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NAVAL ARCHITECTS AND MARINE ENGINEERS.

THIRTEENTH GENERAL MEETING OF SOCIETY HELD IN NEW YORK AND IMPORTANT PAPERS READ AND DISCUSSED.

The thirteenth annual meeting of the Society of Naval Architects and Marine Engineers opened in the auditorium of the American Society of Mechanical Engineers, No. 12 West 31st st., New York on Nov. 16, continuing throughout the 17th and concluding with a banquet in the evening at Delmonico's. The attendance was large, the papers varied and interesting and the discussion more animated than usual. President F. T. Bowles, formerly chief constructor of the navy, presided at the sessions.

The report of the secretary and treasurer, Naval Constructor W. J. Baxter, showed a net reduction in the total membership for the year of four, there being now 866 members. There were eight deaths and thirty resignations during the year. The total receipts for the year were $10,620.81, and expenses $9,611.32, leaving a balance on hand of $1,009.49. The society has no liabilities and its present worth, including books, bonds, certificates and furniture, is $24,490.50.

PRESIDENT BOWLE'S ANNUAL ADDRESS.

In making his annual address President Bowles prefaced it with a remark indicative of a disposition to retire from the chair but this was forestalled by a motion of Prof. H. C. Sadler, seconded by Mr. W. P. Stephens, that the old officers be re-elected. President Bowles and secretary-treasurer W. J. Baxter were unanimously re-elected. In his annual address President Bowles said:

"It is the president's duty to briefly recall to you annually the events in our country in the art of naval architecture, but during the past thirteen years of the life of this society this duty has rarely been an agreeable one if measured by the record of the commercial success in shipbuilding. Following the Spanish war, and owing to the purchase of vessels by the government, the increased traffic with Cuba, Porto Rico, Hawaii and the Philippines for one or two years commercial progress in ship building showed a tendency to measure up to the technical progress shown by the members of our society in its proceedings. Since these years there has been a steady decline in ship building both for ocean and coast traffic until the former has reached the vanishing point. Shipbuilding is in satisfactory condition only on the great lakes. There the shipyards are busy and a steady improvement is made in the economy of transportation by the development of terminal facilities and the use of larger vessels. The success of the lake ship builders is unqualified and shows the results which can be obtained by intelligent application to a definite problem. The coast ship-builders on the other hand have little work and deal with a great variety of problems and their progress is therefore subject to the handicap of diversity of work and the small quantity involved. In the past year three or more coast ship yards have gone out of business, two have sold their plants and several more are in the hands of receivers. This is a melancholy record. A few events afford us some hope for the future. During the past year the Merchant Marine commission appointed by congress spent some seven months in a careful investigation held throughout the seaboard and lake cities of the United States and presented a bill to promote the national defense and to establish American ocean mail lines

PRESIDENT F. T. BOWLES.

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which met the approval of the committee in both houses of congress. I quote a few words from their report:

" 'The American shipping in the foreign trade has been for forty or fifty years the only American industry exposed directly to foreign competition that has not been protected by the government. There is no need to look beyond this one sentence for the explanation of the hard fact that this one American industry has halted and shrunk and while all others have made prodigious increase.

" 'The American merchant marine is essentially a floating factory which is built and maintained on the American wage rate but there is this vital difference that while the land factories are covered by national protection averaging almost 50 percent, these floating factories, the few that are left, work up and down the ocean without any protection whatever save that granted to a few steam lines by the postal subventions of the law of 1891.

" 'An adequate American ocean fleet would mean the saving to this country of $100,000,000 which now goes to build up the commercial power and naval strength of Europe and Asia.'

"The bill suggested wisely includes provisions intended to create and maintain a reserve of seamen for our naval forces. There have been added to the navy during the past year five large armored cruisers and there will be added during the coming year seven or eight first-class battleships and two armored cruisers and the resulting demand for increased enlisted force in the navy has brought keenly home to our naval officers the force of the maxim that 'No nation can maintain an efficient navy without a prosperous commercial marine to support it.'

"During the past year evidence has accumulated that there is ample field for development and extension of the coastwise steamship traffic and it is unquestionable that this can be promoted by the careful study of naval architects to the necessities of the trade if carried on simultaneously with the improvement in terminal facilities. The tendency will no doubt be much enhanced by the encouraging efforts for the development of the marine turbine in the United States."

SOME PROBLEMS IN FERRY BOAT PROPULSION.

Reading of papers then became the order of the day.

The first paper to be read was upon the subject "Some Problems in Ferry Boat Propulsion" by Col. E. A. Stevens, vice president. Col. Stevens has for several years made a specialty of ferry boats and his investigations are exceedingly interesting. The subject matter of the paper is well conveyed in his introduction as follows:

"The propulsion of double-ended screw boats offers some difficult problems in screw design. The subdivision of the power shown by the indicator is very complex, and its exact distribution is, with the knowledge at hand, well nigh impossible. There are also few instances in which screw design is of more importance. The Scranton class of boats recently put into service on the Hoboken ferries can serve as an illustration. The wheel originally designed for these boats did not give satisfactory results in backing. It was decided to try a wheel of another type. The main dimensions were as follows:

	Wheel No. 1.	Wheel No. 2.
Diameter	10′ 0″	9′ 3″
Pitch	11′ 1½″	10′ 6″
Dev. area	38.8sq. ft.	38.5 sq. ft.

"The first wheel had blades of oval outline with rounded backs and a directrix curving to the rear. The second wheel was of the so-called DeLamater type, with sections designed to give equal efficiences in both motions and with vertical directrix. With greatly reduced slip the second wheel consumed about 20 percent more power at the designed speed without any appreciable gain in backing power. On the subsequent boats the original wheel was cut down in diameter and area."

Power curves were submitted to show the results obtained by the Scranton with both wheels, and by the Scandinavia, a sister ship, with a smaller wheel of the same type. Col. Stevens then proceeded to discuss the results obtained to which attention will later be paid in the columns of the *Review*.

DISCUSSION OF COL. STEVENS' PAPER.

Prof. H. C. Sadler: Mr. President, there is one remark that I think Mr. Stevens might explain a little more, and that is when he makes the statement that the thrust deduction minus the weight gained in those boats is probably negligible in design. It seems to me that in an ordinary ferry boat with the bow propeller that the thrust deduction will remain much about the same as in an ordinary boat, but the weight gained will be less. I should expect that the hull efficiency in these boats would certainly not be more than 95 percent, and probably less. I would like to know what Mr. Stevens thinks about that. This is, to a certain extent, I think, borne out by the efficiency curves. All the curves of total efficiency are very low for this type of boat. That is, the ratio of e to i never gets over 45 percent, if we omit the Edgewater. And there is no doubt there is some error in the Edgewater's curves, for it is practically impossible for this curve to run up in the way as shown. I should also like to ask Col. Stevens if he has performed any experiments or has noticed any torsional vibrations in the shafts of these vessels. I think there is no doubt that there will be considerable torsion vibration set up.

Col. E. A. Stevens: The only method I know of in which the algebraical sum of thrust deduction and weight gained could be obtained is by single screw type; so that in those which have been attempted, as the Cincinnati, the Bergen and the Edgewater, the hull efficiency worked out at very close to 99, somewhere over 98. When you come to the double screw condition it is practically impossible to separate the race augment from the total sum. That efficiency falls to a very low figure; but I know of no process to obviate it. I have tried a number of times to get at some process by which the thrust deduction could be estimated apart from race augment, but I have been simply floored; I have been unable to get anything further. I suppose there is an increase in the screw motor for any design. The whole cannot be charged up to race augment, and no serious error will be involved, as the two losses are of kindred nature, and no difference really occurs, whether it occurs from the action of the bow screw or the stern screw. As to torsional vibration, the shafts of these boats are usually much larger than would be used in ordinary practice. I think that the very fact that they have been operating now for some time, very nearly 20 years,—some 18 years—practically without shaft troubles, shows that the shaft is working under very low stresses. I have not been able, except in one case, to suspect that vibration was arising from torsional vibration of the shaft. I have never taken any such measurements as would give me any practical data on the subject, except the fact that I have never been able to trace the vibrations to an unknown cause, which I would then call torsional vibration.

Mr. F. L. DuBosque: Col. Stevens has said that it is impossible to analyze the performance of screw on ferry boats. It comes to us with a great deal of satisfaction. We have been experimenting with these inclined wheels, as we call them, for the last 8 years, and we have been trying to analyze the forces to determine what size and type

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of wheel should be used on any particular ferry boat, and we reached conclusions and tried the wheels and have not got good results. Now it is a fact that the forward weight of a screw propeller ferry boat has a very peculiar influence on the bow of the boat. I think we will have a great deal of difficulty in finding out what it is; but it is undoubtedly, as the author has demonstrated, very satisfactorily, that an inclined wheel is very superior for a ferry boat to one with a straight axis. This fact was discovered by us some eight years ago, as I tell you, experimentally, not on any calculations, but from the thought that a poor backing wheel would be a good ferry boat wheel. I had the privilege some years ago of illustrating that, I think, at one of the meetings of this society. But the author states that he has reduced the diameter of wheel No. 1 in applying it to the Scandinavia, but does not tell us how much.

Mr. Stevens: The figures between the Scandinavia and the Scranton are six inches.

Mr. DuBosque: A considerably larger diameter is permitted with an inclined back wheel than with one that is straight, and I think the conclusions of the paper seem to point to that too, because the No. 1 wheel on the Scandinavia seems to show greater efficiency than the No. 3 wheel, and I so claim it on the Scandinavia. We find a 30-knots' speed is gained with a trifle less horsepower. There is one feature about this type of wheel however, that is more important, and that is manoeuvering qualities. It seems that with the wheel blades pointing backward the water has a very much better chance to get to the rudder, and on all boats that we have fitted with inclined wheels the steering qualities have been immensely improved. That is a very important feature.

The backing qualities are very much improved, because the wheel, being larger in diameter and more effective in pushing, exerted a backing force on the forward end of the boat in a pushing direction. One thing I would like to say in reference to the design here. I am inclined to think that the form of blade as given on the Scandinavia could have been very much improved, not only to increase the speed of the boat, but to increase the manoeuvering qualities. We are now building these blades very wide and fairly narrow at the tips—in fact, somewhat like one of the turbine wheels described in one of the papers to be read here today.

Prof. H. C. Sadler: Can you get a large enough wheel for the power?

Mr. Du Bosque: Yes, it usually does. To cite an example, we took a 9-foot diameter wheel off the Cincinnati, which has been a nine-foot diameter, 11-foot six inches pitch. In place of that, we put nine-foot six inches diameter, twelve-foot pitch, and the revolutions were increased from 115 to about 120, and the speed of the boat, I may state, was increased for all I know. We never made a progressive trial with the new wheels, but the performance is very accurate, as we keep actual records of the actual time taken by every boat on every trip, and by applying a number of these on ferry trips we get a comparison of the speed of the boat.

Mr. Stevens: It is, of course, with great diffidence that I arise to say anything on the subject of ferryboat propellers after Mr. Du Bosque. The credit of originating this type of wheel is certainly due to Mr. Du Bosque. He is the man who first attempted this wheel, and, I think, on the Chicago, wasn't it? And subsequently on the Newark; and I am free to confess that a great many of my ideas have been drawn from what Mr. Du Bosque has told me, very generously and freely, as to his experience. The statement as to the relative diameter of the straight wheel by Mr. Du Bosque entirely bears out my experience. As to the steering, I have not had sufficient experience to state. The only boat I had knowledge of was the Scranton, and the Scranton steering was very satisfactory under both conditions. If anything it is a little better with the curved wheel. In backing we find on the Scranton that the first wheel, the ten-foot wheel, was very sluggish in starting. This was due somewhat to the setting of the valve gear and the arrangement as to the valve, which lifted very quickly and gave very little compression. The vessel with the original wheel was very sluggish in backing. Personally, the management was extremely anxious to place the boat in the immediate service, and the chief engineer considered it was due to the wheel being too large. The Scranton No. 2 wheel was even worse in backing, although considerably smaller in diameter. It was very much more sluggish.

The question as to tips is to a great extent a practical one, and with too fine a tip it needs a little coursing in order to stand up in ice conditions. I might agree with the author however that a wider blade than that shown would probably give better results. As to whether the directrix is curved or in a straight line, I have absolutely no experience. Mr. Du Bosque having tried both I suppose—my impression would be that the effect would be comparatively small in either case.

Mr. D. W. Dickie: Might I ask Col. Stevens if the trial was made of this wheel by putting a wheel on the bow of the ferry boat and leaving off the one on the stern, and making comparative results with the one on the back, by turning the model back end to?

Mr. Stevens: No, these boats were tried just as they run in service, that is to say tried with the first wheel, and both wheels were taken off and the No. 2 wheel tried, and some of the boats were tried with slightly different wheels, but all of the same type as the wheel of the Scandinavia. They were a little bit different proportions in diameter—all of the same pitch, but slightly different proportions in diameter.

Mr. Dickie: The point I was trying to bring out was this: That you make a regular trial of the wheel on the stern of the boat from a model experiment, just as you would from any commercial ship, then make a trial of the wheel on the bow of the boat with the other one, and then make an algebraical sum.

Mr. Stevens: No, these wheels have been tried at the Model Experimental Basin. The hulls were approved at the Model Experimental Basin, but at an entirely different time. The scales used in the experimental basin are about 20 ft. in length for the hull and 16 in. in diameter for the propeller.

PAPER ON EXPERIMENTS WITH VENTILATING FANS.

The second paper was upon the subject "Experiments with Ventilating Fans and Pipes" by naval constructor D. W. Taylor. In his introduction he said:

The experiments described in this paper were undertaken for the purpose of learning more than was known about the capacities and efficiencies of fans such as are ordinarily used for ventilation purposes on United States naval vessels and to obtain much needed information to enable systems of ventilation piping to be intelligently designed. Forced or mechanical ventilation of living spaces was fitted by Ericsson on his monitors, and ever since that time has been a feature of our naval vessels. The largest naval vessels now building will each be homes for nearly a thousand men, and the adequate and satisfactory ventilation of such vessels is a work of difficulty and magnitude. Table I appended gives the number, size and rated power of the electric fans used for ventilating the battleship Mis-

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souri. Later battleships are larger than the Missouri, but the ventilating systems fitted on them follow generally along the same lines. Steam-driven fans were fitted on the earlier vessels, but during the last ten years electric fans have been adopted enabling the number of separate systems to be increased, thus reducing the number of openings for ventilating pipes in water-tight bulkheads, without the serious disadvantages which would follow if a network of steam pipes to small fans were fitted all over the ship.

"While both plenum and exhaust systems of ventilation are fitted, the tendency is at present to fit the latter for special purposes only, the main reliance for ventilating living spaces proper being placed upon plenum system which force the air in. For my part, I consider the plenum system distinctly preferable wherever it is applicable, not only because it is more efficient, enabling the same quantity of ventilation to be obtained with less power, but because it is best adapted to conditions on shipboard and preferred by the majority of people who live aboard ship. There are arguments on each side of the question, but this is a case where the experience and preference of people affected must govern. The obvious advantage of the plenum system is its positive nature. If 10,000 cubic feet of air are blown into a compartment we know that so much fresh air has reached its destination. If 10,000 ft. of air are exhausted from the same compartment its place will certainly be taken by 10,000 feet of air from somewhere, but it does not necessarily follow that it will be fresh air. The principal objection to the plenum system is that in cold weather it is very difficult to avoid unpleasant draughts from it and it is apt to be shut off entirely. In the tropics, however, where ventilation is most needed, the cooling currents from the plenum system are found grateful and pleasant.

"The experiments to which I invite your attention have been made at the Experimental Model Basin from time to time, as opportunity permitted, during more than three years. In practice the solution of the problem of ventilation requires the solution of two interdependent problems.

"1. Given a properly designed system of piping and outlets, with what initial pressure constantly maintained at the fan outlet will this system deliver the required quantity of air?

"2. What fan will deliver the desired quantity of air to the properly designed system of piping at the required pressure with a minimum expenditure of power?

The experiments first undertaken dealt only with the second problem, and were directed to ascertaining the real efficiency and capacity of fans, such as were then being used for ventilation. It was desired from the first, in these experiments, to obtain results from the fans, as nearly as possible, in their actual working conditions. This required that each fan should discharge against pressure into a pipe somwhere near the size of its outlet, and that the pressure and velocity of the air as discharged into the pipe from the fan should be determined simultaneously with the actual power being absorbed by the fan proper. For determining the power delivered to the fan a spring torsion dynamometer was used, identical in principle with the dynamometer used for determining the power absorbed by model propellers and described in my paper of last year on "Some Recent Experiments at the U. S. Model Basin." As a matter of fact, the fan dynamometer was built and in use before the propeller dynamometer. For driving the dynamometer two special electric motors, one large and one small, were used, each being fitted with Ward-Leonard control, giving it a wide variation of revolutions, so that any number of revolutions desired could be obtained and steadily maintained from one or two hundred per minute up to twenty-five hundred per minute.

"When it came to the question of determining the output from the fan or the pressure and velocity in the pipe near its outlet, it was necessary to develop special apparatus and appliances. Anemometers are notoriously unreliable. Several were purchased and tested, but no two would give the same result, and even if they had been accurate it would have been very difficult to use them inside the pipe. As the result of careful consideration it was concluded to use Pitot tube methods."

Then follows a most elaborate account of the experiments held with the conclusions reached. The experiments showed that the ventilating fan of commerce had an actual efficiency in the neighborhood of 50 percent with sporadic exceptions.

Regarding piping Mr. Taylor summarized his conclusions thus:

1. Angles of branches.—For the general run of branches make the angle anything less than 45 degrees. Thirty degrees is a very good angle to use, but it is not necessary to adhere to it rigidly. For branches at the extreme end of the main, where the velocity is very much reduced, the branch angles should be increased and the last branch should generally lead off at 90 degrees.

2. Elbows in branches.—For one 90-degree elbow add 3 feet to the length of the branch; for two, add 7 feet, and for three, add 10 feet. For elbows less than 90 degrees add in proportion. This applies to elbows whose radius to the center of the pipe is 1½ diameters. A smaller radius should not be used.

3. Outlet for branches.—Connect the branch with its outlet fitting by a cone expanding 1½ inches to the foot, making its diameter such that the air velocity at discharge will be 1,000 feet per minute.

4. Mains.—Use round mains wherever practicable. Make the standard conditions at the first outlet 5 pounds pressure, and 2,000 feet per minute velocity. As the branches lead off do not change the size of the main until sufficient air has been removed to reduce the velocity to a value between 1,200 and 1,500 feet per minute. Then contract the main with a taper of 1½ inches to the foot until the area is so reduced that the velocity again becomes 2,000 feet per minute. Repeat the contraction wherever necessary, but do not reduce the final diameter of the main to less than twice the diameter of the last branch.

DISCUSSION ON CONSTRUCTOR TAYLOR'S PAPER.

Mr. Linnard: Those of us who have had to design ventilating systems for shifts know in the past how much difficulty and doubt existed as to the thing—any sort of designing data that was accepted, and I think it may be said that these are the first public results which give experimental data and designing rules which will enable anybody familiar with laying out ventilation piping to design a system which can be relied upon to be satisfactory after its installation, a thing which has hardly been achieved heretofore; and this has been attained, as I am personally aware, after a very long and exhaustive set of experiments to which Mr. Taylor has devoted a great deal of time and attention, too. And I think the thanks of this Society are especially due to him for such valuable data in such a convenient shape for design work. I don't know whether there are any fan manufacturers or designers here, but it seems to me that we should be glad to hear from any of them, if they are here, as actual data of this character, as far as I am aware, has not been published to any extent by such fan manufacturers.

Mr. John H. Macalpine: Mr. Chairman, I have read Mr. Taylor's paper, at least the greater part of it, with great care and interest. And I think there is much exceedingly instructive and useful in it. There is one point however with which I have been very strongly struck, and

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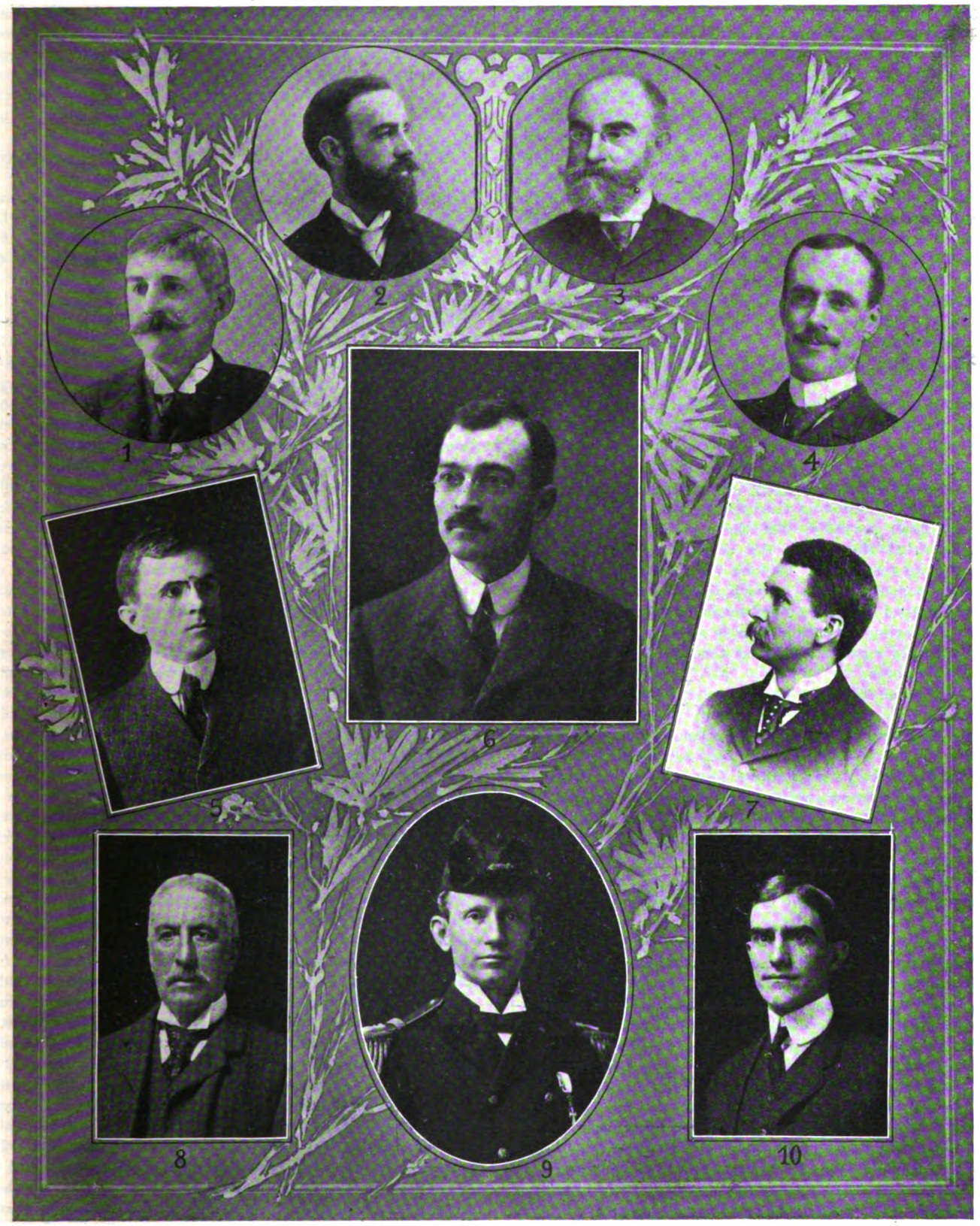

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that is the very low efficiency which he has found for fans, an efficiency which he states for the conditions of ship ventilation come to about 50 percent, in some cases the efficiency rising to 60 percent or more but usually for higher pressures than allowed. This is a very different result from what is usually accepted among many who have made fan tests, and the question is of great interest where the difference comes in. Mr. Taylor relies altogether on the Pitot tube, which he says on page 2 that he is convinced its accuracy is well established by independent investigations. That is a point on which there is a very great deal of difference of opinion. Mr. Taylor mentions an experiment on page 4 wherein, with an axial flow, he gradually drew back the Pitot tube from the mouth of the pipe delivering air, and found that the Pitot tube also exerted a pressure higher than the atmosphere. He says: "If the Pitot tube had been an error, as used to be supposed, the pressure recorded in the center of the free jet would have been materially below that of the atmsophere, while as a matter of fact it never quite reached the atmospheric pressure."

Mr. Taylor: That is the side pressure, not the impact pressure.

Mr. Macalpine: I don't think that that experiment proves very much for us. On page 27 we have, in the appendix, the well known equation given for steady flow of air, but in developing the theory of the Pitot tube there are certain assumptions made. They are not entirely independent. They may be stated as three: first, that there should be steady flow; secondly, that there should be axial flow; thirdly, that the air in the central stream should be brought to rest. Mr. Taylor's experiments go up to 22 pounds per square foot, which, with a square delivery, would extend to 140 feet per second. With such velocity even approximately steady flow is an impossibility, and in fact there is a proof of that in the body of the paper itself.

Mr. Taylor: That 22 pounds per square foot is not all velocity.

Mr. Macalpine: No, but it runs up to that pressure.

Mr. Taylor: To the pressure, but not velocity.

Mr. Macalpine: Well, there was a velocity of 100 to 200 feet per second spoken of in the paper.

Now, as to the necessary assumption that the center of the stream line is brought to rest. Of course that would be so where the stream line is perfectly axial. If it was one degree from being axial it would not be true. If it were 5 degrees it would be very far indeed from being true.

In fact, on page 4 Mr. Taylor says that in his experiments it was thought necessary to use ten or more tubes in large pipes in order to reduce to a negligible qauntity the error due to the velocity of the air. That is a well-known fact; and if he had given us the pressures at the different parts of the pipe, we would have found also that the pressures were very far from uniform, I mean a considerable percentage of the trouble. If we refer to a test of these pressures with Mr. Taylor's mode of experimenting it might appear that it was effected by the instrument, but if we refer to a test by Commanders Carnegie, Dinger, and Johnson, at the Society of American Engineers, in February 1905, they also used as one of their modes of measuring, Pitot tubes. The nozzle experimented with was 24 inches diameter, in which twelve measurements were taken in positions shown. Taking one of the measurements, while one of the tubes showed 7¼ inches pressure, another tube showed 6¼, or 16 per cent over the lower. Now I am not taking up one of the experiments alone, nor were these pressures, these large gradients, transverse gradients, at the 24 inches apart. In two of the experiments we have the Pitot tubes within about six inches of one another, registering ⅞ inch difference of pressure. This is not a perfectly constant feature, showing that it is not an experimental error that has been introduced; but is so far constant as to show that it is a real fact that high and low pressures occurred at these points near one another. Now, if we have such heavy pressure gradients transverse to the tube, it naturally means that the stream lines are very much curved, that is that there is a great deal of vortex motion. The Pitot tube takes no note, no proper note, of this vortex motion.

Before passing on, I might refer to another result got by Messrs. Carnegie, Dinger and Johnson. They have a box; they deliver into a box which is only a smaller enlargement of the pipe, and they measure the pressure by putting in three tubes—three I think—transverse to the stream. Now it is well known that a tube transverse to the stream will give a very defective measurement of pressure; as a matter of fact, taking the averages, while the Pitot tubes gave—the pressure in the box of course should have rather higher value than that at the nozzle, since the velocity is a good deal lower, but instead of having a higher value where the Pitot tubes gave an average of 6.64 in the experiment made, the pressure in the box was 4.6. That is to say, the Pitot tubes registered 44 percent more pressure in the tube with air blowing across it. It is not, I think, open to doubt, that a similar error of lesser degree will exist if the pressure is absolutely axial, which cannot be realized. Now, as further evidence regarding the unsteadiness, the defective measurements due to Pitot tubes, I might say that on July 16, 1904, I saw two fans tested. They delivered into a box cut of which the air flowed through an 18-inch nozzle. The pressure here was pretty high, 21 inches of water. The Pitot tube was very small, but the pressure measured at different parts of the opening of the nozzle was very different indeed, and at one part, over one area, it was exceedingly unsteady, the water jumping eight or ten inches or more continuously. Here we had what, if it had been a steady flow, would have been an axial flow, and the tube so small that it would have no sensible effect on the current. Now the question is, is there another way of testing? A very frequent way of testing—there are two others to which I referred—the first, a very frequent way, is by delivering the air into a very large box so that the air currents, instead of being exceedingly swift, are very much reduced, not by any means seriously. There is still kinetic energy, which will register itself in the pressure gauge, but they are very much reduced, so that the pressure gauge has not a very powerful current blowing across it. A large kinetic energy is transferred into potential energy.

Referring again to that test on July 16, both methods were used. By the Pitot tubes, taking an average as near as could be, from the excessively unsteady measurements, there was a calculation of 55 percent efficiency. The observations from the gauge in the box gave 69 percent, a difference of 14 percent. Now, as I have pointed out, there were still powerful currents in the box, and consequently axial efficiency would usually be considerably sensibly higher than that often shown by the box. In most experiments the results which I have seen—and I have seen quite a number—whether there is a difference between the Pitot tube results and the pressure gauge results, I think in all cases the Pitot tube result was the lower. Now there have been a great many fan tests made, in which the efficiency has been believed to be considerably over 60 percent in efficiency. I have seen fan results where, even with Pitot tubes, it was calculated from the observations that the efficiency was as high as 70 percent. That at Trunham which I have referred to was 69½ per-

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cent, taken from the pressure—69 percent taken from the pressure in the box. I think 69½ was the actual figure.

I might say that there is a third result. Of course many of these fans are sold under a guarantee, and those who make the tests or those interested in seeing that they get what they pay for, but still they accept a figure even over 60 percent efficiency. But I might quote one result at the 38th street power house in this city where a Sirocco fan had been installed and tested over a very considerable range of pressure. This was not tested by anyone interested in the fan, but by the engineers who were accepting the fan. For 1.19 inches pressure, between 5 and 6 pounds per square foot, the efficiency is given as 67.3; for 4.12 inches of pressure, or about 22 pounds—21 or 22 pounds—about the higher pressure. One of the engineers of the company, of the Edison Power company, calculated an efficiency of 89.4 percent. I happen to know very intimately Mr. Davidson, the inventor of the Sirocco fan. His regular calculations are based on 60 percent efficiency, and he has never yet had a fan returned from failing to deliver the required quantity of air.

I might draw attention to figure 5. I think anyone acquainted with the various fans will have no difficulty in recognizing this as a Sirocco fan; and I wish most emphatically, in the name of my friend Mr. Davidson, to enter my protest to it as in any way representing what a Sirocco fan can be made to do. In fact, some of Mr. Taylor's fans are not unlike the Sirocco, but he runs them the opposite way. I think if Mr. Taylor ran some of his fans the reverse way—

Mr. Taylor: I have tried it. They run a good deal worse.

Mr. Macalpine: Now I have in my pocket a letter from my friend Mr. S. C. Davidson. I might say Mr. Davidson is a man who has made what most of us would consider a fortune, through his scientific and patient investigation. He has made a much greater number of fan tests than anyone else living. This was written to me from England on October 18 of this year, and of course without any reference to any discussion, and it admirably sums up what I have just been saying. I might say that Mr. Davidson has not only developed a very large fan business, but I think I am correct in saying that he has all the work of the British Admiralty, which he has captured by the excellence of his fans. Mr. Davidson writes:

"'I would here add that I have but little faith in these tests run with Pitot tubes, because these tubes are depending for their record upon a parallel flow of air through the tube in which they are located, but as a matter of fact air from a centrifugal fan does not pass through the tube in a parallel line, but corkscrew fashion, and this is an inherent action with the discharge from all centrifugal fans, whether Sirocco or old type make, but the corkscrew twist with the Sirocco might catch the Pitot tube at a particular distance from the can nozzle at more of an angle than an old type fan might catch it at the same distance, i. e., the corkscrew swirl might be longer or shorter in pitch with the Sirocco fan than with the other. Hence the Admiralty here have declined to use Pitot tubes in tests, and adhere to having the fan discharging into a receiving chamber of large dimensions, wherein velocity is changed into an average static pressure, then letting the air out of this through an opening, and then along a considerable length of pipe, the diameter of which is more than twice the diameter of the opening flowing into it, so that at the end of this pipe the velocity of discharge is reduced so that they can take the anemometer readings carefully over the whole end, whereby they get at the exact volume that comes through the opening, and by this means they have standardized their tests, so as to avoid using Pitot tubes in which, like myself, they place no reliance. It was with a test of this latter description that our investigations were made here, and with which we obtained an efficiency for the Sirocco of 73 percent.

James A. Clifford: I wish to compliment the author of the paper upon the care and thoroughness with which the experiments with their details have been carried out. The question of the method of measurement of volume, pressure and horse power of air has always been a matter of much discussion, and in many ways of much confusion, and the author of the paper deserves a great deal of credit for the definite way in which he has outlined the method, object and results of his experiments. Referring to page 3 of the paper I am glad to note that the anemometer was discarded in the experiment and the Pitot tube substituted. I think that the design of Pitot tube used is a very decided improvement over the old forms which have been used. I have used the Pitot tube for the measurement of velocity for several years, placing the tube at the outlet of a cone at the end of the delivery pipe of the fan. The measurements, being based on the assumption, which is corroborated by the author of the paper, that the static pressure had entirely disappeared, and that the velocity pressure was the only one to be measured. This was my method of dodging the problem which the author of the paper has so satisfactorily solved, that of accurately measuring the static pressure of a moving column of air.

The results obtained by the experiments on friction of air in pipes are very interesting, and I am surprised to see how close the experiments made on large pipes approach to the values given in certain fan manufacturer's catalogues. The tables in the catalogues were based on experiments on pipes of very small diameter and length, and it is gratifying to note that these experiments confirm the previous ones made on pipes smaller than are ordinarily used in practice.

Another of the usual methods of the manufacturer is confirmed by the results of experiments on the loss of head in tapers. (See page 15). The author of the paper concludes that a cone expanding at the rate of 1½ in. to the foot is the best angle suited for either expansion or contraction of an air duct. I have made a practice of using a 6 degree cone when testing fans, and have assumed that this was the cone which offered the least resistance either to the contraction or expansion of the air. The 6 degree cone corresponds to a taper of about 1¼ in. to the foot. I wish to express my entire agreement with two statements as made by the author of the paper (page 25). 1. That the efficiencies of various runners differ to a very slight extent when tested in similar casings with same size of inlet and outlet. 2. That in small fans the loss through shaft friction masks the efficiency vibration due to runner and casings.

I would suggest that in future experiments, more attention be paid to the form and size of inlet and outlet, and less to the vibration of the efficiency of different forms of runners and casing. I have reason to believe that an investigation along this line will be productive of good results.

I wish in some measure to criticize the method used by the author of the paper in determining the volume of air delivered by the fan. He has used the method which consists essentially of obtaining measurements of three quantities, viz: The area of the pipe; the static pres-

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sure and the total pressure; the velocity pressure being the difference between the total and the static pressure. The older form of measurement of the volume consists essentially of the measurement of two quantities, viz: The effective area of a conical mouthpiece and the velocity pressure at the outlet of the mouthpiece, the static pressure being zero. The velocity pressure in the first method is a very small quantity. For instance, when the velocity in the pipe is 2,000 ft. per minute the velocity pressure is equivalent to only about 3-10 in. of water, whereas the velocity pressure as obtained by the second method over a smaller area is approximately equivalent to the total head as obtained by the first method.

In other words the velocity head on which depends the volume delivered by the fan, horse power and efficiency of the fan, by the first method is obtained by the measurement of quantity in which a 100th of an inch of water corresponds to an error of 3 percent, whereas in the second method under usual conditions an error of 100th of an inch of water in the velocity head corresponds to an error of one half of one percent in the volume. As a compromise between the two methods I would suggest a method where the static pressure is measured in the center of the pipe and the amount of air is regulated as suggested at the outlet of the pipe in the more usual way. This method, I think, combines the advantages of the two methods spoken of and enables the various quantities measured to be of such magnitude that only ordinary care is necessary to obtain satisfactory results.

Referring to page 7 of the paper in which the author states that "There appeared to be no commercial make of fan on the market which gave promise of efficiency for ship ventilation exceeding 50 per cent," I would say that there has been no inducement offered to the manufacturers to produce a fan of greater efficiency. In the average fan installation the efficiency of the apparatus depends so much upon the application of the fan that the efficiency of the fan itself is often of comparatively little account. For instance in the ordinary heating apparatus where the fan is operated by a steam engine, the exhaust from the steam engine being used in the heater, in this case, the efficiency of the fan is of very little consequence inasmuch as the heat of the exhaust steam is made use of. I have estimated that the entire amount of fans required for marine service in the course of a year would only constitute about 3 percent of the business of one of our large fan manufacturers, and the request of the navy department seems to be about the only urgent one for a fan of greater efficiency. Furthermore the demands of the navy department for an absolutely convertible fan is of greater hindrance to the promotion of a fan of increased efficiency. If we note plate 40 of the author's paper we see a picture of a fan casing which is probably more efficient than the average but, yet a casing along these lines would not admit of the required convertible design because the distance from the center of the shaft to the bottom of the fan casing varies largely as the direction of the discharge is changed. If we look again at plate 40 the distance as scaled on picture from the center of shaft to the outlet side of casing is 1⅝ in. and to the bottom of casing 2⅜ in. This means that if the fan discharge is changed in direction that the height of the fan is changed materially and the distance between the bottom of the fan and the floor is changed. The more nearly circular casing, while perhaps not as efficient, lends itself more readily to the convertible design. Aside from this the navy department has never specified any efficiency for fans. I am of the opinion that if a more efficient fan was demanded of the manufacturer it would be forthcoming. It goes without saying, however, that a fan possessing these qualifications would cost much more than the present one. There would not only be in my opinion a large increase in cost but it would mean a larger fan for a given volume. For the benefit of those who are not familiar with the term convertible as applied to fans I would like to say that it consists of a fan whose sides are interchangeable by which either hand of discharge is obtained and whose cone plate is drilled equidistant all around, so that the fan housing can be secured to it at any angle so far as it relates to the fan outlet.

Prof. Cecil H. Peabody: It is unnecessary to say anything more upon the importance of this investigation. The thing that strikes me particularly is that it comes out too simple, which important investigations do not always succeed in doing. I cannot help, however, wishing that the appendix were as simple as the results. At the bottom of page 28 the author is using what is the ordinary equation for hydraulic head as applied to a gas, and as he uses the same term exactly in the paper, I wonder a little at the necessity of producing this result through an equation of even the complexity which appears here, when it would have been sufficient to say that the temperature and pressure do not vary enough to make the ordinary hydraulic head inaccurate. As a matter of fact, here hydraulic head is probably more accurate for our purposes than a more complex equation.

Mr. D. W. Dickie: Why not ask Mr. Taylor if he has tried an outlet for the pipe which was not conical in shape, but was made in the form of the McReady louvre and made parabolic in the section as approaching from the inlet. That is the same end of it, but going out to the parabolic curve to the outlet.

Mr. Taylor: No, we tried only the conical outlet.

The President: Does Mr. Taylor desire to make any further reply to the discussion?

Mr. Taylor: Mr. President, referring to Prof. Peabody's remarks—it is true it is a little complicated; that is why I put it in the appendix; but even starting with the most complicated equation, starting with the gas, which was compressible for the particular conditions which we are considering, we can readily reduce the complicated equation to an ordinary hydraulic equation. It is undoubtedly a fact that with the same pressures used in ventilation, air should behave very much as water does. The variation of density is infinitesimal.

In reference to the question of efficiency—Mr. Macalpine appears to consider the efficiencies very low as compared with efficiencies which have been frequently attempted. That is all correct. I have seen fans as high as 96 percent, and I suspect some data would show efficiencies over 100 percent if you followed it out practically, but I may say that I am not the only worker in this field, and I know of one large firm which has made a large number of experiments of late with various types of fans, and I am not familiar with the details of their results; but I know one of their representatives was inclined to criticize my results as giving too high efficiencies. They have used the pitot tube and other methods too. I am very glad that Mr. Macalpine brought that up, because the question of the accuracy of the pitot tube method I believe is beyond dispute. The same question was raised several years ago in connection with hydraulic work, before another society, at which time the pitot tube was very much discredited. Since then there have been a number of workers in the field. There are two things that you measure with this pitot tube; one is the impact pressure, and the other is the side pressure, which I have called the static pressure.

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Now, with reference to the impact pressure: Mr. White in New Orleans made an experiment with water. He made a tank in which he kept the water level constant. He made a small hole in the bottom and allowed the water to flow out steadily. In the center of this jet he inserted an impact pitot tube. He did not measure the side pressure—a small part; then he connected that to a gauge, and he found that no matter whether he made the pitot tube like that (illustrating on blackboard), a fairly large end with a very small opening, or if he made it like that (illustrating), conical, or if he made it like that (illustrating) going the other way—the water would invariably rise within a very small fraction of one percent to its original level. That would seem to conclusively demonstrate that as regards impact for water the pitot tube is correct.

Then my friend Prof. Zahn of the Catholic University has made a very large number of experiments with air. He has a tunnel in which he soaks the air. The air goes through like that (illustrating). Now he can stop up the end of that tunnel and produce a slight amount of vacuum in it. He has made a very small opening in the end and has taken the pitot tube and placed it first out here (illustrating). The air flows in like this; keeping it in the center of the jet, like this, he moves the pitot tube gradually in until it comes entirely in the tunnel. The head is unchanged; that is to say, the impact of the air, the velocity of the air, being that due to the head, the air is brought entirely to rest in front of the tube and the head remains constant.

Now, the reference to the side opening, which has been the real difficulty with pitot tubes. I should like to ask Mr.Macalpine, who refers to a number of experiments with pitot tubes, whether those tubes were of identical construction.

Mr. Macalpine: They were not the same design.

Mr. Taylor: That, I think, is absolutely essential to accuracy. Here is a pipe, we will say (illustrating). That end is closed. If you make a small hole in the side you will get aspiration across it? It is entirely unreasonable to suppose that the pressure in a moving stream of air could be accurately transmitted to the inside of a pipe like that. There is a small opening of that kind, where you will find that the tube I use has quite a long narrow slat parallel to the direction of the moving air, one on each side and I think it is obvious in principle that that is much more apt to convey the pressure.

Now with reference to the side pressure. I should have explained that the pressure to which I referred, moving the tube in a moving jet of air, was the pressure made on the side of the tube—not the impact; and the evidence that that remained with a uniform jet of air—it is probably a shade above the atmosphere, because a certain amount of pressure is necessary to continue the force of the jet against friction.

It would appear to me fairly conclusive evidence that this tube would register the pressure with some accuracy, that that jet would come through a pipe, and if there were any peculiar corkscrew motions in the air they would probably continue after the air left the pipe. There was no reason to believe that the tube did not measure the pressure with great accuracy. There is a further experiment which has been made by Prof. Zahn with a tube. He has taken a pitot tube of this kind and determined simultaneously the velocity by the pitot tube and by the independent method, and the results vary very little. Now, with references to the differences of velocity over the pipe section. It is true that there are differences of velocity, but the original apparatus had separate manometers measuring the pressure, the impact pressure and the side pressure from each separate tube. These variations were not very serious. They may have been perhaps ten percent. These tubes were not placed at the immediate outlet of the fan, but a little distance down the pipe, and the extreme turbulence with which air leaves the caisson has had a chance to somewhat subside.

In the experiments made to which Mr. Macalpine referred, the pitot tubes, I should certainly say, although I am not familiar with the details, that they have small side openings.

Mr. Macalpine: The assumption is that the pressure at the side of the tube is the same as the atmosphere, and consequently the tube should give a higher record than the tube.

Mr. Taylor: Of course if you assume the pressure you may prove almost anything.

Mr. Macalpine: Your own experiments show that that pressure was positive.

Mr. Taylor: In a free jet, yes, but it may not have appeared, because in the experiments to which you refer it was a free jet. If anyone has noticed a stream of water flowing from the head—

Mr. Macalpine: With regard to Prof. Zahn's experiments, of course, as I stated, sometimes the pitot tube results agree with the pressure results; sometimes it does not. Then I was going to refer to what I said a moment ago, in these tubes there was no sized opening at all; it was a plain tube to the best of my recollection, and according to Mr. Taylor's experiments the side pressure in the tip would be slightly above the atmosphere, which of course the tube did not register. In these experiments of Carnegie, Dinger and Johnson the variations of pressure over the nozzle were very marked indeed. In the experiments of Carnegie, Dinger and Johnson the pressure was some 6 inches, between 6 and 7 inches I think. But there was nothing like a steady flow. It was a flow in which there was a very large vortex motion. I might say that in these experiments of Prof. Zahn I find it confirmatory of the pitot tubes results. It is precisely what one would expect, because the vortex motion would not be reduced. The vortex motion would induce a slanting flow on the pitot tube.

Mr. Taylor: If you resolved the pressure parallel and perpendicular you have got to get an appreciable angle before you can get—

Mr. Macalpine: The fact that very different pressures are registered must then demonstrate what we are trying to get at, that a large percentage of energy is taking place after vortex motion, and that since we do get differences in pressure the flow out of some of the tubes must be very considerably lower than ten degrees.

Mr. Taylor: Well, as I say. I have tried up to an angle of ten degrees, and it produces in my tube no appreciable effect. What was the length of the nozzle from the fan?

Mr. Macalpine: In Carnegie's experiments the nozzle was at the end of the box. I have the papers here. In the experiments fans—two fans, were delivered into quite a large box on the side, and the nozzle was at the top, I should say, while of course the motion had been entirely changed. The box was interposed to reduce the substance of the swell.

Mr. Taylor: Were they converting nozzles, something like this (illustrating)?

Mr. Macalpine: Oh no.

Mr. Taylor: Parallel nozzles. Well the point I wish to make in regard to the nozzles is this. A great deal depends, in the experiments which I have referred to, in which the pressure in the moving jet was reduced to that in the atmosphere.

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The pressure in a moving jet of air immediately at the mouth of a pipe is reasonably above that of the atmosphere, and I think the total heads to which Mr. Macalpine refers quite as high as 120 lb. In one case the pressure in the jets would be very much above that of the atmosphere. I don't think those experiments are at all comparable to those which I have made. Mr. Macalpine speaks of other methods, and he seems to prefer the method of blowing air into the box. The trouble with that is that air enters the box with a certain amount of kinetic velocity and thereafter carries with it a certain amount of kinetic energy, and it is very uncertain how much of that kinetic energy is transformed into pressure. Mr. Macalpine says much of the velocity is transformed into kinetic energy, much of the velocity head, but there is no way of finding out how much that is, and when you are attempting to obtain accurate results it is necessary, I think, to use apparatus and methods which will approximate theoretically to the result without having gas. The formula for the loss of heads of a jet at enlargement of the pipe is well known, but I have never seen that there has been any experimental demonstration of it.

Now with reference to the mooted question of efficiency, Mr. Macalpine spoke of the efficiency of a certain type of fan, and I don't think I need go into the discussion relative to the merits of various types of fans. It was my intention to avoid any such thing. They appear to be, so far as I could judge, all equally bad. I may say, however, that if there is a fan on the market with an efficiency of 70 percent, I believe the Bureau of Construction would very promptly specify that efficiency. It has never specified an actual efficiency for its fan, for the reason that there seems to be very little choice. They all seem to be about the same. If there were a fan which could be relied upon to show an efficiency of 70 percent, I think an efficiency of 70 percent would be very promptly specified.

Mr. Clifford performs an experiment—a test, with a restricted delivery. That is a very good test to find out certain things. You find out what the fan does through a contracting nozzle, but you gain very little information as to what the fan will do when discharging into a full-sized pipe. We tested some fans with the restricted delivery method, and gave very satisfying results. They were electric fans. The fans were put aboard ship, and owing to the resistance of the actual piping being a good deal less than that of the conical appliance, they delivered a great deal more air. They all performed more than the manufacturer expected, but they used so much power in delivering the air that they destroyed the motors.

Now I don't know whether I can fully agree with Mr. Clifford that the 70 percent fan would be permitted. Is that ever demanded?

Mr. Clifford: I didn't say 70 percent; I didn't say any percent.

Mr. Taylor: The question of a slightly increased first cost in a thing like this is comparatively a minor one. As fitted aboard ship, our friends in one test delivered 1½ cu. ft. of air per minute per watt.

The best results combined efficiency with under 30 percent.

Mr. Clifford: I would ask Mr. Taylor if he understood those as entirely final. We propose to test in the same manner as you describe, only that we get the static pressure in the center of the pipe, while the end of the pipe is reduced.

Mr. Taylor: I thought you were referring to that restricted delivery cone.

Mr. Clifford: No.

Mr. Taylor: Then I beg your pardon; I thought you were referring to that.

Mr. Clifford: You get the static pressure in the center of the pipe and the velocity here.

Mr. Taylor: If you assume that all of your head is transformed into velocity, your pressure head. That is one point. Mr. Clifford spoke of a difference of 1-100th of an inch in the water gauge, meaning 3 percent velocity. With a floating manometer you can measure a 100th of an inch with facility.

Mr. Clifford: Well, I suppose that is right on experimenting work, taking particular pains to get absolute results, but you put those instruments in the hands of an ordinary man in the shop and you find that the results are not as good; and we are trying to simplify the method of the tests.

Mr. Taylor: You have got to get an extraordinary man in the shop.

Mr. Clifford: We have used the pitot tube and were very glad for a little sketch that we got from Mr. Taylor, which we followed out, and in which we obtained very much better results than we ever did from the older type. I must also agree with him as regards the efficiency of the fans. The tests that we have made show that the efficiency is about as he states. Of course there is one thing to be considered, and that is that in the application of a fan wheel the efficiency that Mr. Taylor has given is a maximum efficiency. You can vary that efficiency almost to zero by the application of the old fan. That is a question that is overlooked by a great many engineers today. They think that they can get a 40-in. fan and do their work. They won't pay for a 90-in. fan that they could do their work with. In regard to the test inefficiencies of some foreign makes of fans, I cannot agree with Mr. Macalpine's statement. We tested almost every fan imaginable, and we have not been able to get any such efficiency either on fans made in this country or in any other country, and we have tested them all under similar conditions. If there was any error in our tests it went right through the whole lot of tests, which should at least have shown a fair comparison. And I agree with Mr. Taylor that he has not been able to find that fan for ordinary work which will do much better than 55 or 57 percent. But I think if any efficiency was absolutely specified I still would have to adhere to that remark, for the reasons that the fan business covers such a broad field that if you were to make a wheel, for instance, we will say, for all the different classes of work, and made a wheel that would be most efficient for its particular application, you never know where to stop. It would not be a very good policy for the manufacturer to pursue. Of course from an engineering point of view it is entirely different; but that is the manufacturer's position, and he doesn't usually do a thing like that until he is absolutely asked to do it. So if this fan was required you would probably get it. If you do not ask for it you never will get it probably.

The President: In closing this discussion the chair might state that these experiments were undertaken for the practical object of enabling the design-ventilation system to be made with reasonable certainty and to avoid complaints which were coming in from chief engineers and surgeons that the ship was full of pipes but there was no air. A conversation such as this took place. Mr. Taylor said that a number of fans had been received at the Model Basin, and he wanted to know what they were there for, and he was told that they were there for him to find out what they could do. Now the paper before you is the result of three years of scrupulous scientific investigation, and fully justifies the labor and expense which has been put upon it.

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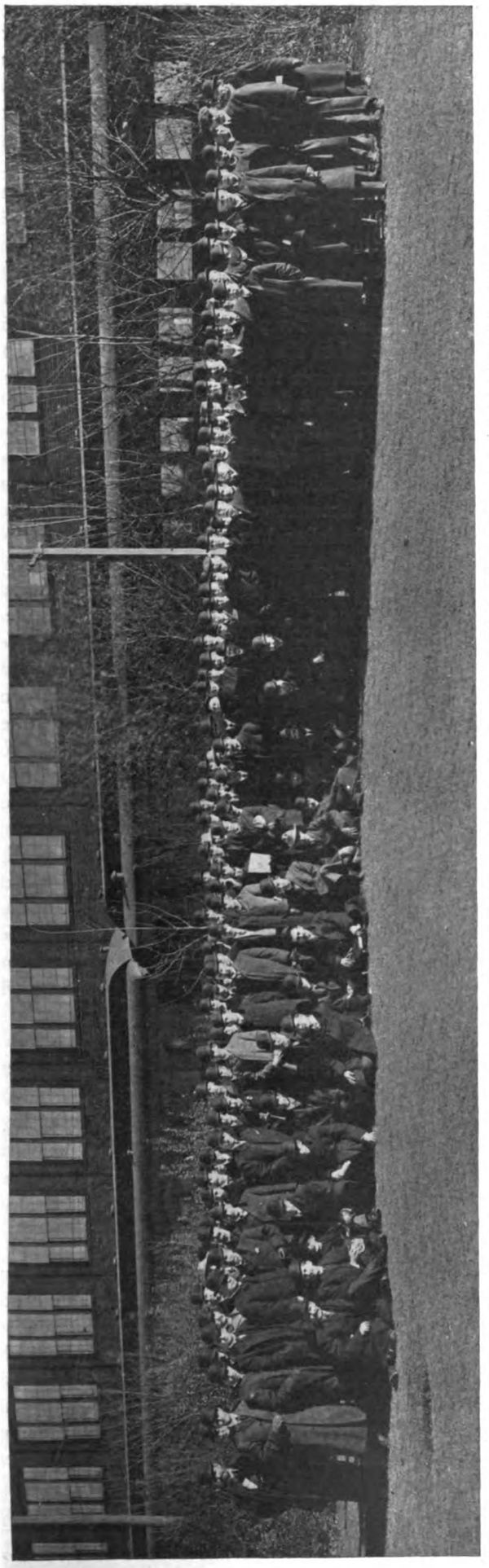

NAVAL ARCHITECTS AND MARINE ENGINEERS AT THE PLANT OF THE GENERAL ELECTRIC CO., SCHENECTADY NEW YORK.

PAPERS ON SCREW PROPELLERS.

Mr. D. H. Cox, acting secretary, read Prof. W. F. Durand's paper "Experimental Researches on the Performance of Screw Propellers" and also the paper of "Some Results of Tests of Model Propellers" by A. V. Curtis and L. F. Hewins. In his paper Prof. Durand said:

"In the fall of 1897 a preliminary paper on this subject was read before the society, giving the result of certain tests made on a series of seven model propellers, all of the same pitch ratio and form of blade, but with varying widths, thus giving a series with area ratio varying between the limits of .18 and .72. Further prosecution of the work was delayed by various causes, but at length it became possible under much improved conditions in the canal of the hydraulic laboratory of Cornell University, and during the past two years, through the aid of a grant from the Carnegie Institution of Washington, D. C., the work has been carried forward in the intervals of other duties of the observers and other uses of the canal. At the present time the original program (including the examination of several series similar to that first reported on and with selected pitch ratios covering the field of normal design) has been completed, together with certain special and auxiliary investigations not coming within the scope of the present report. The propellers used in the first investigation have also been included in the general program carried out with the improved means made possible by the experimental canal, so that the present report covers in effect the performance of 49 model propellers distributed over the field of pitch and area ratios, as shown by the following table:

Pitch Ratios.

Area number.	Area Ratios.	.9	1.1	1.3	1.5	1.7	1.9	2.1
2		.18	.18	.18	.18	.18	.18	.18
3		.27	.27	.27	.27	.27	.27	.27
4		.36	.36	.36	.36	.36	.36	.36
5		.45	.45	.45	.45	.45	.45	.45
6		.54	.54	.54	.54	.54	.54	.54
7		.63	.63	.63	.63	.63	.63	.63
8		.72	.72	.72	.72	.72	.72	.72

The diameter of all propellers was 12 in. and the diameter of the hub 2.4 in. The shape of all blades was elliptical, the maximum width in tenths of the radius being expressed by the area number in the table.

The introduction to the joint paper by A. V. Curtis and L. F. Hewins was as follows:

"The investigation of model propellers at the U. S. Experimental Model Basin have been continued as opportunity has permitted, and the object of this paper is to present to the society the results of experiments on two, four, and six-bladed propellers. The experiments were carried on under the direction of Naval Constructor D. W. Taylor, U. S. N., and are supplementary to those described by him in the transactions of this society for the year 1904. The series of propellers experimented with include 24 four-bladed, 9 two-bladed, 8 six-bladed, and 2 special three-bladed propellers. The propellers were all 16 in. in diameter, of uniform pitch, and, excepting the two special propellers, were the same as to size of hub, finish, blade outline, and blade thickness as those used in the preceding experiments on three-bladed wheels. In the four-bladed propellers, the same six pitches were used, namely, 6.4 in., 9.6 in., 12.8 in., 16.0 in., 19.2 in., and 24.0 in., but only four widths of blade were used, the widest being omitted, owing to the difficulty of planing overlapping blades. In the two-bladed series the six pitches were used in connection with the mean width ratio of .200, and in addition the four widths were used in connection with the pitch ratio 1.00. The six-bladed series consisted of two widths

CONTINUED ON PAGE 28.

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Owners of steel vessels on the lakes that have been delivered within the last two months or who will get their boats before the opening of navigation next year, will be ahead in the game from fifteen to twenty thousand dollars. When contracts were let four or five months ago, the price of structural material alone in quantities sufficient for a boat of 10,000 tons capacity was that amount lower than the figures at which it could be purchased at the present time. To all intents and purposes, this increase in value is simply a matter of history repeating itself, as will be recalled by going back to the time when the barges of what were formerly the Rockefeller fleet were sold at almost twice their original cost and the purchasers even then thought they were getting quite a bargain. There is no question that vessel property has rapidly increased in value during the present rise in value of structural material. This same applies not only to boats of recent construction, but to those of modern type which have been built within the last three years as well, as their value as carriers, which is synonymous to their money earning capacity, is equivalent to the more recent boats and stockholders have had their holdings increased in proportion to the cost of new boats as compared to their older properties. A typical case which calls this unusual condition of affairs strongly to mind is that of a new steamer built by the American Ship Building Co., the contract for which called for 1906 delivery, but which was turned over to the owners in time to make several trips this fall. It is estimated that this boat with the ruling freights will earn from $15,000 to $20,000 before the close of navigation and pay the stockholders a dividend before they have actually put up all their money. This particular boat when she was launched was figured to be worth $15,000 more than it would have been when the contract was let, a few months before.

The city of St. Clair, Mich., has this fall set an example which, if followed by the larger cities on the lakes in the same spirit, would greatly help out a situation which on account of the increasing number of large boats on the lakes, has become a serious problem to owners. St. Clair has offered free winter quarters in the Pine river for all boats wishing to lay up at that port. Marine City, for several years past, has made the same proposition and has been freely accepted. Lake Erie ports, after the close of navigation for several years past, have been so badly congested by vessels laying two or three abreast in winter quarters that it has been a difficult matter for harbor craft and fireboats to navigate to best advantage. A large winter fleet is a great benefit to any city. Not only will that city's residents derive a benefit from the repairs made during winter, but also from the laying up and fitting out of the fleet, each of which items is of no mean proportion. Excessive charges made for dock space have driven vessels away from Detroit and several other cities and the Steel Corporation last year laid up a large fleet in the bay outside of Erie.

The near proximity of shipyards is a feature which attracts an owner if there is any large amount of overhauling to be done and Buffalo, Cleveland, Detroit, Chicago, Milwaukee and Duluth always draw a large proportion on account of these facilities. Toledo has lost some prestige as a laying up port on account of the floods always caused by the spring freshets.

ATTENTION OF MASTERS

Masters of vessels on the lakes who are receiving their copies of the *Marine Review* at the marine post office at Detroit or at Sault Ste. Marie are requested to send their home addresses to this office in order that the paper may be sent to them during the closed season of navigation. Prompt compliance with this request will prevent confusion when the marine post office closes and make it possible for masters to receive their papers continuously. If desired, another change may be made when the boats start out again next spring.

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OHIO RIVER IMPROVEMENT ASSOCIATION.

The annual convention of the Ohio River Improvement Association held at Cairo, Ill., Nov. 15, 16 and 17, was one of the most enthusiastic in the history of that organization. The attendance was larger than usual and included representatives of the upper and lower Mississippi river improvement association and other organizations interested in the betterment of conditions on the rivers. The delegates were welcomed by Hon. Charles S. Deneen, governor of Illinois, Mayor George Parsons of Cairo, Col. John S. Ainsthorpe, representing the Cairo Board of Trade, and by President E. A. Smith of the Cairo Commercial Club. For 3 days ways and means for securing a deep waterway in the Ohio river were discussed and before the convention adjourned it was decided to meet next year at Portsmouth, O. All of the old officers were reelected unanimously and a set of resolutions expressing the sentiment and outlining the policy of the association for the coming year was adopted.

The most touching incident in connection with the convention was the memorial service in honor of the memory of Capt. John F. Dravo. These consisted of a prayer by a local minister and J. Frank Tilley of Pittsburg, for twelve years a daily associate of Capt. Dravo, supplemented the report of the memorial committee with a personal testimony of the esteem with which the lamented member was held by all who knew him. Albert Bettinger, of Cincinnati, and Capt. J. F. Ellison, both close friends of Capt. Dravo, added their tributes to the memory of the deceased.

The following resolution, which was unanimously adopted, sets forth at length the purposes and objects of the association, and was adopted without a dissenting vote:

The Ohio Valley Improvement Association in its eleventh annual convention, assembled at Cairo, Ill., November 15 and 16, 1905, notes with grateful appreciation progressive action by the Fifty-eighth Congress in the direction of accomplishment of the aims of this association in the provision made to change the depth of dams Nos. 2 to 7, inclusive, from six to nine feet minimum stage of water, and in providing for completion of survey of the whole river under the auspices of a competent board of United States engineers who are clothed with authority to make thorough investigation, report and recommend actions as to all conditions affecting further improvement of the river.

The association recognizes in this action encouraging assurance of a definite policy of waterway improvement under Government control. Your committee submits for reaffirmation the declaration of principles approved by the association at its meetings in Parkersburg, 1902; in Evansville, 1903, and Huntington, 1904.

First.—We reaffrm as the sense of this association that the improvement of the Ohio river from Pittsburg to Cairo should be such as to provide a nine-foot stage at low water to provide for which we respectfully ask that all appropriations and surveys necessary to the completion thereof be provided for at the earliest practicable time.

As to obstructions to navigation—Resolved, that Congress be requested to cause the removal of all artificial obstructions to the full and free use of the Ohio river and its navigable tributaries, to which end it is recommended that the laws of Congress for the preservation of harbor lines be strictly enforced.

Third—As to recommendations of engineers—This association advocates that the improvement of the Ohio river be made according to the report and recommendations of the United States engineers approved by the Secretary of War.

Fourth—This association recommends the construction of a dam at or near Henderson, Ky., so as to make a depth of six feet of water on the miter sill of the lower dam in the Green river at Spottsville, Ky., which is necessary to make available the improvement of the Green river already completed, as the result would also be to make a pool that would afford safe harbor and adequate water at all seasons for the large population and great commercial and manufacturing interests of the cities of Evansville, Henderson and Owensboro. We therefore favor the project in advance of a general survey of the lower river.

Fifth—Whereas, experience has shown that judicious dredging in time of low water has proved extremely beneficial to low water navigation, therefore be it

Resolved—That we recommend a liberal and timely use of dredges during the progress of the lock and dam construction.

Resolved,—That this association renews its protests against the maintenance of narrow channel spans across navigable rivers.

Resolved,—That we petition Congress to enact such laws as will effectually control the rebuilding of bridges to the end that in reconstructed bridges the obstructive features shall be eliminated. Your committee submits the following additional recommendations:

Sixth—Resolved,—That the officers and Executive committee of this association be requested to arrange a comprehensive system for securing information as to the traffic moved in both directions on the river, to which end it is recommended that arrangements be made with local organizations wherever they exist for the accurate performance of this work under the supervision of the Executive committee.

Seventh—It is recommended that the officers and Executive Committee establish a permanent bureau of publicity, whose duty it shall be to compile and distribute information concerning the work of this association, to the end that the people may be reliably informed as to the necessities for an expression of public sentiment in support of a liberal policy of appropriation, which we hope may become a definite policy of the government. In this behalf it is recommended that the active cooperation not only of local organizations but of the entire commercial public be invoked in the thorough distribution of information prepared by this bureau.

Eighth—This association expresses the hope that the initiative arrangements already made shall be pushed vigorously to completion, and that the meeting may realize fully the most sanguine expectations as to its influence and results.

Ninth—Resolved,—That the association recommends the maintenance by the government of an adequate force of engineers to be available for the prosecution of river and harbor improvement, to which end it is suggested the appointment, or employment of civil engineers from private life.

Tenth—Resolved,—That the Committee on Resolutions extends to its Chairman thanks for indulgence and also the impartial manner in which he has presided over these meetings.

The following officers were unanimously re-elected; President John L. Vance; secretary and treasurer, J. F. Ellison; Executive and finance committee, John L. Vance, J. F. Ellison, George Puchta, O. F. Barrett, Paris C. Brown, Albert Bettinger, Edwin C. Gibbs, R. W. Wise, M. B. Farrin; vice presidents for Pennsylvania: George H. Anderson, Pittsburg; W. B. Rogers, Pittsburg; James A. Henderson, Pittsburg; for West Virginia: Hullihen Quarrier, Wheeling; D. A. Mossman, Huntington; B. W. Peterson, Wheeling; George W. Summers, Parkersburg; for Ohio: Albert Bettinger, Cincinnati; H. A. Marting, Ironton; D. J. Sinclair, Steubenville; for Kentucky: W. W. Hite, Louisville; W. A. Patton, Catlettsburg; S. A. Fowler, Paducah; W. C. Williams, Louisville; for Indiana: F. B. Posey, Evansville; M. C. Garber, Madison; Charles Hegewald, New Albany; J. H. Odell, Evansville; for Illinois: George Parsons, Cairo; J. C. Willis, Metropolis; E. A. Smith, Cairo.

R. C. Monteagle has resigned from the Gas Engine & Power Co. and Charles L. Seabury & Co., Consolidated, Morris Heights, New York, to become the chief engineer of the Atlantic Works, Incorporated, East Boston, Mass. He left the Morris Heights firm immediately upon the delivery to the government of the gunboats Dubuque and Paducah.

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CONTINUED FROM PAGE 25.

of blade associated with four pitches, the intermediate pitches 12.8 in. and 19.2 in. being omitted. The two special three-bladed propellers, numbered 76 and 81, were models of propellers of existing ships, and the blades of each were raked aft at angles of 9 degrees in the case of No. 76, and 13½ degrees in the case of No. 81. The blades of No. 76 were also rotated back on a helical surface, through an angle of about 15 degrees, in a direction opposite to the go-ahead motion of the propeller. Both propellers had spherical hub, and No. 81 had adjustable blades, which were set to a slightly greater pitch than that to which they were planed. The following table gives the necessary data for all the propellers experimented with:

TABLE OF PROPELLER VARIABLES.—A.

Propeller Number. Pitch ratio.								
.4	.6	.8	1.0	1.2	1.5	Mean width ratio.	Total developed area sq. inch.	Developed area ÷ disc area.
Four-blade propellers.								
31	35	39	43	47	51	.075	32.37	.1610
32	36	40	44	48	52	.125	53.95	.2683
33	37	41	45	49	53	.200	86.32	.4293
34	38	42	46	50	54	.275	118.69	.5903
Two-blade propellers.								
—	—	—	70	—	—	.075	16.19	.0805
—	—	—	71	—	—	.125	26.97	.1341
67	68	69	72	74	75	.200	43.16	.2147
—	—	—	73	—	—	.275	59.35	.2951
—	—	—	73	—	—	.275	59.35	.2951
Six-blade propellers.								
—	—	—	—	—	—	.075	—	—
82	84	—	88	—	92	.125	80.92	.4025
83	85	—	89	—	93	.200	129.48	.6440
—	—	—	—	—	—	.275	—	—

TABLE OF PROPELLER VARIABLES.—B.

Propeller number.	Pitch inches.	Pitch ratio.	Diam. hub inches.	Mean width ratio.	Total developed area sq. in.	Developed area ÷ disc area.
Special three-blade propellers 16 inches diameter.						
			Spherical.			
76	16.45	1.028	4.25	.266	74.92	.3726
Cut 19.41			Spherical.			
81 Set	20.18	1.261	4.43	.273	75.81	.3771

DISCUSSION ON TAYLOR, CURTIS AND HEWINS' PAPERS.

Mr. D. W. Taylor: As a worker in the same field as Prof. Durand, I should like to express my appreciation of the very valuable results which he has given the society.

Mr. Macalpine: I am sorry I have not had time to read Prof. Durand's paper, which only got into my hands last night, but I have read with care and great interest the paper by Mr. Curtis and Mr. Hewins, continuing the experiments which were initiated by Mr. Taylor some time ago. Of course the accumulation of the propeller bow is excessively interesting and important; but in writing last year to the discussion I pointed out that with a model propeller and a fullsized propeller at corresponding speeds, the pressures per square inch on the surface of the model propeller are very much lighter than the fullsized propeller, and consequently while the fullsized propeller may have such a pressure that cavitation is about to set up, the model propeller will be very much removed from that. That is to say, the model will give much more nearly a stream line action than the fullsized propeller, and consequently, since the government is at the back of the experiments, I would again suggest that they be supplemented by propellers on active ships, and that there ought to be new and properly made trials to open up the subject. I think that is very important, because I do not think that at the limited pressures that we have to work at in many cases nowadays we can be quite sure of making the steps from the model experiment to the fullsized experiment without such a guide. There is one other thing which I pointed out. These model experiments gave an efficiency ranging up sometimes as high as 8 percent. I stated in the discussion that I had no doubt the efficiency is due to the fact that the model blades were only about half as thick as a fullsized propeller with heavy pressure. I need not give the full statement, but by making the blades of the ordinary proportion the efficiency would probably fall to 69 or 70 percent as a maximum. At the time Mr. Taylor did not entirely agree with me. I should judge from the remarks and suggestions made, that probably he now ascribes some considerable influence to the thickness of the blade. In this paper the point that struck me as of particular interest in the light of that discussion was that we have an eye to experiment with two series of experiments with model propellers of the thin type and also of those that are reduced from the natural propeller. For instance, Nos. 19 and 7 to 6 on page 5 are compared. In the thin blade there was an efficiency obtained of 73 per cent. In the corresponding thick blade the efficiency fell to 60 percent. In the case of propellers 24 and 81 the efficiency fell from 75 percent to 61 percent; that is to say, it came down in one case 13 percent, and in the other case it came down 14 percent. Now the interesting confirmation is given that the efficiency was largely influenced by the thickness of the blade, for propeller 81 was planed off on the back towards the edge, so as to get the sharper angle on the back, to a pitch of 30 percent less than that of the face. It is shown in figure 10. The section shows the metal that was removed, and the maximum efficiency might respond by rising about four per cent.

I may say that the forms of the curves for the very thin blades and for the thick blades were very different indeed. That is to say, the maximum efficiency not only fell, but it was obtained at a very different slip in the two cases. I need not quote the figures designated on pages 5 and 6. In the case of No. 19 the 73 per cent efficiency was obtained at 14 per cent slip, and in the case of No. 76 60 percent efficiency was obtained at 32 percent slip, so that the curves were very different in form. On page 6 we have the thin blade giving 75 percent efficiency at 13 per cent slip, and the corresponding thick blade giving 61 percent efficiency at 20 percent slip. Now I think it will be exceedingly useful if the experiments were continued in the model basin to investigate very fully the influence of the shape of the section and of the thickness.

Col. E. A. Stevens: In carrying out the idea suggested by Mr. Macalpine I would say that I took the trouble to plot out the curves of efficiency for two propellers tried in the Model tank that were reproductions of actual propellers—that is to say, No. 71 and No. 81, both the original and modified. Of all those, to take no comparison with the curves published in paper No. 1 of the Scandinavia, Edgewater and Scranton, those latter sections are all sections of ferryboat wheels, and decidedly heavier than are met with in ordinary practice. Of the six curves thus obtained, five ran in a fairly parallel strip from 12 percent slip up to 40. One curve had a 76 propeller with a peculiar fish shaped section. It does not reach the bunch of the other curves until it gets up to a slip of about 30 percent. The other curves, you will notice in paper No. 1 and in the present paper, all have a very decided efficiency at zero slip. The maximum efficiency reached by any of these wheels was by that of the Scandinavia at 18 percent slip. One went up to 1.665. The loss is in the Edgewater also at 18 percent slip, which is .590, those being the maximum efficiencies for both of those wheels. In other words, if these wheels—they are all of them of rather fine pitch, very full area ratio and thick blade sections—the efficiency varies from a maximum of 665 down

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to, at working point, somewhere from .55 to the practical range of the slips, which is not very far from figures which one would usually expect to find for propellers of that kind. Personally I have used on wheels of that sort generally from 58 to 62 for the efficiency. I have also taken the trouble to see if I could get to see if I could get any relay in the matter of the number of wheels used compared with the ordinary weight absorbed by a wheel of the area ratio but differing in its number of blades. This can be done very well by plotting cross curves on the curves given in paper No. 4 and selecting a proper area ratio from that, and then plotting the curves from those cross curves. I find that for wheels of an area ratio of 205 and a pitch ratio of 1—I took a slip or pitch ratio simply because that happened to be the handiest one for me to work with then—I find that taking a four-blade wheel as a standard, 100 percent, a 31 wheel will absorb 81 percent; two-blade, 77 percent; and taking an area ratio of 4025, with the same pitch ratio, 1, and taking a four-blade wheel again as 100 percent, the three-blade wheels absorbed 76 percent, or practically the same as in the other case; and the six-blade wheel absorbs 124 percent.

Mr. Taylor: If it lay within my authority the experiment that Mr. Macalpine suggests would be very promptly made, but it is out of my control personally.

CAPT. HOVGAARD'S PAPER "THE CRUISER."

Capt. William Hovgaard's Paper on the "Cruiser" was then read. This will be dealt with later in the *Review*. For the present it is sufficient to say that Capt. Hovgaard recommended the abandonment of the armored cruiser as a type of fighting vessel.

DISCUSSION ON CAPT. HOVGAARD'S PAPER.

Mr. L. Y. Spear: There is one aspect of this paper that I find it very difficult to follow the author's reasoning in connection with it, and that is the line of reasoning by which he arrives at the conclusion that the scout for doing scout duty, should have a displacement of 5,000 tons. I believe he says in the body of the paper that the number of units is not so important to the scout as the individual ability of the ship. That seems to me entirely wrong reasoning. While the development of wireless telegraphy has extended the usefulness of each individual scout, we have not discovered any way of finding the other fellow by wireless telegraphy, and the amount of scouting which you can get out of a certain sum of money depends upon the number of ships you can put out to scout. We have in the present large destroyers the basis of the proper scout. Their ships which we call 420-ton ships are, as a matter of fact, when they go to sea, 600 to 620 tons. They have pretty well demonstrated that they can take care of themselves under all circumstances at sea and that they can maintain a sea speed under all reasonable circumstances which is quite sufficient for scouting purposes, or at least near enough so that with an increase of displacement to about 1,000 tons they would serve every possible purpose that the scout cruiser can serve. But the basis of it all is the number of ships you can get to do a certain duty for a certain amount of money. And why we should stop at 3,000 displacements or 4,000 or 5,000, as the author has done, is a puzzle to me.

I think that to maintain the highest possible speed under all conditions of weather you cannot stop at 3,000, 4,000 or 5,000 tons, but must go on to exceedingly large displacement, 10,000, 12,000 or 14,000 tons. It would seem to me that we are getting very wide of the mark when we build ships which will run up as high as three or four or five thousand tons. The thing that limits the scout is that it can only see just so far, and a hundred-ton ship can see just as far as a 10,000-ton ship.

Mr. Taylor: There are a great many interesting points brought out by the author in this paper and a great many are worthy of discussion, but I wish to say a few words on one particular point, that is the old question that has been with us for so many years, deck armor vs. side armor. The author has gone into the matter with great accuracy and thoroughness, considered it mathematically in the appendix, and finally come to the conclusion that armor should be changeably built to the sides, and no more weight should be given to the armor deck than necessary to its functions. I fully agree with the author in that. We have seen ships built with two armor decks, and one of the first things we find amauteur designers want to put on ships is to put armor on the deck. In our service for a number of years now we have followed as much as possible the dictum laid down by the author.

President Bowles: In making up one's mind as to the most efficient types of ship it is fair always to give some weight to the fact that you do not always expect to meet the ships most recently designed in large numbers, and therefore if any apology is needed for the existence of the Tennessee class of cruisers it is in this, that by the possession of superior speed they can choose their enemies, and that the chances are that with the armor protection and the guns they carry they would be able to engage a very large proportion of whatever enemies they might meet. It appears to me that the Japanese war has produced quite a change in the essential qualities of fighting vessels, and possibly we do not now and shall not for some time yet fully appreciate what those changes mean. It would appear that the value of speed in battleships is much greater than we supposed it was. It would also appear that the value of handiness and small turning surface is not so great as we supposed it was, and I think that we have sacrificed unduly other qualities to those. In seeking for opportunities and for means of increasing the speed of battleships without undue increase in size and cost, these considerations which I have mentioned will remove somewhat. The question of handiness also brings one to the use of the ram. If officers would be willing to give up the ram it would very much add to the possibilities of increased speed. I believe that the weight carried in the bow of the ship and the shape that is involved therein, making an efficient ram, is a great detriment to high speed. It seems to me that the question today of speed of battleships is largely one of the production of the required amount of steam without excessive addition to weight, and that the gain in steam without increase of weight is to be attained in one of two ways, or it really reduces itself to one way by the elimination of handfiring. That is, we must come to the use of mechanical stokers or the use of oil fuel, and to the type of battleship more nearly that called the express battleship.

The use of the steam turbine should enable us to get speeds on a battleship of reasonable cost which will absolutely eliminate the armored cruiser of today and produce a ship infinitely superior to any battleship now afloat. When that result is attained, and I believe it to be attained, there will be no excuse for an armored cruiser, unless a far greater speed can be otained for them on reasonable cost than we now ask for. That is, I think we should have to have a speed of 25 knots instead of 22 in order to justify the cost of an armored cruiser that would only be capable of meeting the inferior battleships. That would be a question which could only be decided by careful study, the prospect being that that high speed would not be justified when the greater part of the services of such a vessel can be performed by very moderate-sized scouts.

Mr. Horace See: I approach this subject with a great deal of diffidence. I heartily agree with the Captain in regard to the abandonment of the armored cruiser; also

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in relation to deck armor. The paper of Commander Hovgaard has been read by me with a great deal of interest, particularly as the subject of abandoning the armored-cruiser and raising the speed of the battleship has for some time been a prominent one in my mind, and heartily approve of his suggestion that such a change is essential. I, however, believe the vessel should not be a big costly one, built on present lines, with high towering straight sides to present a big target, but a more modest, radically different, as well as less prominent one. Superior speed, protection and gun-fire are all important in the battleship, but not necessarily attainable only by increasing the size of the present ship. It being my belief that some light on the subject can be obtained from the past history of the armored-vessel, ask permission to introduce some extracts from it before describing the type of vessel that seems to me to be the ideal—a vessel representing scientific as well as empirical progress.

Although some forty years have elapsed since the conflict, both memorable in history and revolutionary in naval warfare, that took place in Hampton Roads between the Monitor and Merrimac, we find scientific progress in the building of the battleship has not only been at a standstill since that time, but that the world has been slow to recognize the value of that which was made manifest on that occasion, our own country only partly, whilst others ignored it entirely until late years and then like ours adopting only the turret on the deep sea ships. In the language of Dr. Rankin, the size of structure and power of machine "by means of gradual amelioration in materials and workmanship," together with "the exercise of individual ingenuity in matters of detail" or empirical progress has been manifest, whilst the results of experience and observation on the properties of the machine resulting in the incorporation of new features or new combinations reduced to a science cannot be found. In fact in some directions a retrograde movement and that for the worse has taken place. The size of the target having grown, simple forms having given place to complex and, instead of a few large well served guns, a battery of large and medium sized ones have been installed to increase the number of the crew, without adding to the efficiency, together with introducing a greater variety of ammunition to make confusion possible. The armor, instead of being applied around the outside of vessel below as well as above the water line, has also been cut up to form interior as well as exterior elements and arranged not only to increase the weight and cost without adding to its strength but also in such a way on the outside as to receive the full force of the projectile and not to reduce it by change of direction.

When the Monitor and Merrimac are compared with the battleship of today what has been expressed in the above will be made clear. In making the comparison, however, the state of the mechanical arts at that time, the difficulties encountered, the urgency of the situation, the radical character of the production and not the condition existing today, or in times of peace, must be considered to fully appreciate the importance of what was then accomplished, that is, entirely on the basis of their relation to the results obtained in preceding years. Both vessels were primarily designed for harbor defense and to meet existing conditions, thereby accounting for the low free-board of hull proper, which made an ideal substructure for a perfect battleship for this service but not for the deep sea. The Monitor was the superior fighting machine of the two on account of its cylindrical enclosed turret presenting a smaller deflecting target above the waterline, in having a battery of but two guns of the heaviest caliber requiring but sixteen men in the turret out of a total crew of forty four, and of being speedier and handier. Although the Merrimac presented a larger target on account of the extent of the casement yet the ends and sides sloping at an angle of 45 degrees favored deflecting instead of directly resisting the shot. Her battery, however, consisting of ten guns of different calibre, demanding a large crew, how many out of 300 worked the guns is not given, made but twenty-two hits against twenty of the Monitor with but two guns and about one-seventh the complement. The variety of ammunition on the Merrimac must, no doubt, have caused great confusion in finding for each gun its proper shot and operated against the best results.

Those responsible for the type of battleship now in evidence have been unable to get rid of the sentiment about the walls of Old England or to recognize the fact that you can have too much wall, that the height of a battleship should not only be as low as the amount of freeboard demanded will permit but also have its sides inclined where possible, so as to deflect and not stop the prejectile thrown against it, and that the armor should be of such a thickness and so arranged around the vital parts as to meet a projectile on the outside and not take chances by allowing it to enter for a weaker barrier to stop and intercept its destructive effect. Also that the armament should consist of guns of the largest serviceable calibre few in number, in order to do the work with a much smaller crew and to be located in well protected turrets so as to inspire confidence and with it obtain better handling. And, finally, that the model of the vessel and the power installed should be equal to securing a rate of speed capable of commanding the best position.

We would, therefore, suggest instead of the present form of battleship an improved one containing the new features given above and embodying also the salient points of the Monitor and Merrimac as a new type combining the high speed cruiser, and the sea-going battleship in one. The vessel to be of about 10,500 tons displacement having but one deck above an armor belt made 11″ thick from which the sides tumble home or slope at an angle of about 40 degrees starting at 6½″ at bottom and tapering to a thickness of 5″ at the upper deck. The tumble home, however, to work out beyond the forward turret into a raised fore-castle in order to obtain sufficient freeboard to maintain speed in sea way. The guns to be 12 inches, arranged in pairs, one in a turret forward and one in another aft on upper deck. This deck to be 1¼ inches thick as the interior protective deck is to be abandoned except at ends in view of the heavier armor amidships by which arrangement weight will be saved, construction simplified and vessel strengthened. Another modification to be that of increasing the thickness of bottom plating and reduction of frame spacing for about one-half the length of vessel amidships in order to increase strength and resist torpedo attacks. The plating to be 1¼ inches except at turn of bilge where it is to be 1 inch thick, with frames 36 inches centre to centre. By this rearrangement of material, whereby the amount in the neutral axis will be taken to increase sectional area of the upper and lower members, increased strength of structure will be obtained without increase of weight. Bilge keels are to be retained but those for docking, inviting damage from the torpedo, are to be abandoned in view of stiffer bottom. Instead of a speed of 19 knots in battleships built or now building we propose to increase it to 22 or equal to that of the armored cruiser made possible by reduced weight of superstructure, armor, armament and by the adoption of a model well suited to attain it, together with the employment of engines and boilers of a design for obtaining from the least weight and with the least smoke or waste of fuel the highest efficiency under all conditions.

The table will show how such a vessel will surpass the large low-speed one with thick armor and heavy guns as well as that of high speed with thinner armor and lighter guns. In the first place its height will be at least one deck less so as to present a smaller target with the sides above the belt sloping upward to deflect instead of stopping the projectile

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and without openings to invite its introduction. Then the extra thickness of the belt will permit fighting at closer quarters acompanied with a more destructive work on thinner armor if guns equal to those of the low-speed vessel and superior to those of the high. With the reduced number of guns there also comes the reduced complement, consequently less space required for their accomodation and supplies, together with the possession of a more compact organization and with it higher efficiency. And last, but not least, this superior fighting machine can be obtained in less time, at very nearly one-half the cost of a vessel presenting a larger target, offering inferior protection, possessing less strength, equipped with no heavier guns, slower by more than three knots and calling not only for double the complement to fight her but also the additional expense connected with their employment. Such a vessel will present a type combining the best features of the battleship with those of the high-speed cruiser and one superior to the battleship for all around work, equal to the armored cruiser in speed and superior to it in fighting, one from which can be obtained the best and surest results with the least amount of money and in the shortest possible time, together with being more readily manned in view of the smaller complement of men.

Two such vessels as proposed, carrying a combined armament of 8 12-inch guns against 4 12-inch and 4 9.2-inch with 11" belt against a 9", with a speed of 22 knots against that of 19, with a target at least 7 ½-ft. lower, inclined instead of being vertical, and a crew no greater in the aggregate, can be obtained at a cost but 6 per cent greater than that of the battleship King Edward VII.

Let us now turn from the King Edward VII type of battleship and consider the latest fad or the one termed the big—more properly the biggest—as the 10,000 ton ship cannot be called small. This is to be 12 12" guns mounted in 6 turrets—4 of which are to be broadside, which means that guns of but 2 can be used to form with those at each end one broadside, so that but 8 guns will be available for this purpose. This vessel will no doubt cost complete, fully equipped, in the neighborhood of £11,850,000. If it is compared with the cruiser-battleship in the matter of gun fire alone the latter's superiority will be found to stand out more prominently, as 7 ships, costing about the same amount of money as 3 bigger ones, will present a broadside fire from 28 guns against 24 in the 3, or nearly 15 per cent more.

It is then reasonable to assert that the cruiser-battleship will be highly efficient, be more useful and give more trouble to a foe than the bigger ones, consequently of greater value. The superior speed making it easier to govern the tactical situation as well as possible to engage an enemy in detail and secure the best position to harm the leading ships without engaging the rest of the fleet. The reduced height with thicker armor affording at like range superior protection against attack thereby lessening the amount of injury from gun-fire. The guns being of one calibre the smaller crew can be more quickly disciplined for the work, so that better results are possible in less time. The importance of this latter condition will be more fully realized when it is borne in mind that officers as well as men have to be secured as well as trained so that the smaller complement and simpler conditions to be faced will shorten the time required to complete the complement as well as to obtain from it the highest efficiency—one of greatest importance in times of peace as well as war.

The world has run mad on larger battleships, although we now have big ones, without taking into consideration their limitations or the possibility of creating something better without increasing the size. The empirical has throttled the scientific, as well as blinded the intellectual vision from beholding the smaller but more powerful as well as active agent close at hand. The personal equation, equal in importance to that of the ship, has been delegated to the back-ground, mobility sacrificed to the imposing vulnerable Goliath and simplicity to arrogant display.

If the aim is to have big things then let it be a big flexible fleet for big concentration with big guns for big destruction, big speed for big results and big ships for big work, but not feeble monstrosities for big targets which like the big Indian eat much—money when being built as well as when in commission or out of commission—to become obsolete in a few years and then thrown into the scrap heap with big loss. Let it be a fleet not only capable of whipping the enemy at the beginning of the encounter, but also sufficiently large and speedy to complete the victory by blocking the escape of any member of his fleet.

Capt. Hovgaard:—First as to the remarks made by Mr. Spear about the scout. I would say this, that I do not object at all to the idea that the destroyers, especially large destroyers, should be used, and are very suitable for doing part of what here is called scouting service, but it will always be or the scouting service in a very narrow sense. If we read the remarks here made about the qualities that should be possessed by a scout, it is stated here that they should possess a sea speed higher than that of the armored cruiser, with greater endurance, and the battery should be sufficiently powerful for fighting other scouts, etc. Now all these conditions are necessary for an ocean scout. These qualities cannot be secured in a small ship; they cannot be obtained in any form. Alone, the requirement of seaworthiness and high endurance is enough to altogether make these small ships impossible, and also their armament is always defective. they cannot keep anything like the speed of three or five thousand ton scouts. They can only be used at short distances from the field of the vessel they are scouting. If it was a question of scouting duty over great distances, then such destroyers would clearly not be useful; if they were sent out several hundred miles ahead of the fleet they would be exposed to be lost. What is required is a few ships that can pierce the enemy's lines with tolerable safety and run away as soon as they meet a third-class cruiser or destroyer; and I think therefore that such large scouts with real seagoing qualities will always be required; but that design of course prevented the use of the smaller ships for scouting. Wherever the conditions are favorable for their use, on the contrary, they ought to be there used.

As to Admiral Bowles' remark, I would say that when I talked about the armored cruisers, the Tennessee and the Minotaur and other large cruisers. I maintained that they ought to be abandoned. I do not criticize at all the designers of those cruisers. I am so far from criticizing the design of the Tennessee that I think in the Tennessee was produced the best result that could be produced under a given displacement. Once the essential conditions are given of a ship of 22 knots and of that armament, then the design of the cruiser is given, and the designer cannot be responsible for the policy of it but only for how that policy is carried out.

As to the increase of speed of battleships, I speak about that in the paper. In that way we raise the whole level of the battleship. It is not a few, but all battleships that can be so increased in speed. And then we are at the same point. The admiral in command of the fleet will want a few ships that are swifter than the ordinary type of battleships. So the whole question is a real one, and no speed, however high, will help us if we shall still want a few ships that are faster than the main fleet. So that, as in land warfare we want something faster than infantry, so here we shall want something faster than the main fleet.

As to Mr. See's discussion. The new type of ships that he proposes. There is one feature I would ask Mr. See: what is the freeboard of that type of ship?

Mr. See: Freeboard ten feet amidships and aft, with raised forecastle.

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Mr. Hovgaard: Ten feet is the freeboard we have had in several ships in this and other navies, and it has been proved that as soon as the speed came up to about 14 or 15 knots, ten feet freeboard was not enough. The ships were wet, the guns could not be worked; and the next type that was designed was given higher freeboard, and as soon as the speed was raised, even that was not found enough. The freeboard was then increased still more. And in this way we have, from years of experience, arrived at a type of both battleship and cruiser of some 18 to 20 feet freeboard, at a speed of 18 to 20 knots; and it may not be unlikely that we shall have to build a forecastle on those ships. But to have a ship going 22 knots with ten feet freeboard would be impossible, while I think the gun axis— —

Mr. See: Excuse me, here is a diagram of it.

Mr. Hovgaard: As far as I can see, the gun axis is no higher than it is in the Indiana or the Kentucky or Kearsarge. If you will drive the Indiana at 22 knots I doubt very much whether it is possible to work the guns. It looks very tempting to obtain a great result on a small displacement, but whenever it has been attempted—and it has been attempted a great many times—it has always proved a failure, for the reason that you cannot secure the fundamental qualities of seaworthiness. If the guns cannot be worked as soon as there is a little rough sea, all the saving in displacement and money is of no use; the ship will not be able to do anything like what is required from it. The fact that a ship has no secondary guns—the proposal there I think is undesirable. Because as ships are now constructed with ten-inch guns any secondary armament is highly desirable if not absolutely necessary. I would say that if the battleship cruiser were made only with 12-inch guns, that that would not be a good type as far as armament goes; but when it comes to cutting down the fundamental quality of seaworthiness of a ship, then I cannot follow Mr. See any more. But judging from other ships, I should say that with a shape like that with 23 ft. draught, that that would have a very short range and not a very great maximum of stability. That is at least my impression.

Beginning with the paper by Naval Constructor H. G. Gillmor, *Marine Review* in its next issue will continue the proceedings of the Society of Naval Architects and Marine Engineers, including discussion on the various papers.

NEW MEMBERS ELECTED.

The following were elcted to membership in the Society of Naval Architects and Marine Engineers at the meeting held last week in New York:

Life Associate: Alva C. Dinkey, President Carnegie Steel Co., Pittsburg, Pa.

Members: James Edward Davidson, assistant general manager, James Davidson, Shipbuilder, Bay City, Mich.

Harold Arthur Everett, instructor in naval architecture, Massachusetts Institute of Technology, Boston, Mass.

Marley F. Hay, superintendenting constructor of Electric Boat Co., 11 Pine Street, New York.

Oliver Zell Howard, marine engine and boiler draftsman, and instructor in mechanical drawing, in the dept. of marine engineering and naval construction, U. S. Naval Academy, Annapolis, Md.

Louis C. Loewenstein, instructor mechanical and marine engineering, Lehigh University, South Bethlehem, Pa.;

Asa M. Mattice, chief engineer, Allis-Chalmers Co., Milwaukee, Wis.

Charles Allert McAllister, engineer-in-chief, U. S. Revenue Cutter service, Treasury Dept., Washington, D. C.

Francis B. Smith, chief engineer, Pittsburg Steamship Co., Cleveland.

Horace Holden Thayer Jr., chief hull draftsman, the Pusey & Jones, Wilmington, Del.

William Wallace Watterson, superintendent of construction, Pittsburg Steamship Co., Cleveland, O.

Edward C. Johnstone, Thomas Andrews Jr., James S. Milne, Charles D. Mowers, Harold A. Everett.

Promotion from associate to member: Joseph Wright Powell, assistant naval constructor, U. S. Navy, assistant to the superintending constructor, works of the William Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa.

Naval constructor W. P. Robert.

Associates: John Lord Bliss, sole proprietor of firm of John Bliss & Co., 128 Front St., New York. Manufacturer of marine chronometers and nautical instruments.

John Wesley Coates, machinist, U. S. Navy, U. S. S. Denver. Care of Postmaster, N. Y.

Leonard Martin Cox, civil engineer, U. S. Navy, supervising engineer, Steel Floating Dry Dock, Cavite, P. I.; William Burder Ferguson Jr., assistant naval constructor, U. S. Navy, Navy Yard, New York; Julius Augustus Furer, assistant naval constructor, U. S. Navy, Navy Yard, New York; Frank David Hall, assistant naval constructor, U. S. Navy, assistant to the superintending constructor, Cramps Shipyard, Philadelphia, Sidney Morgan Henry, assistant naval constructor, U. S. Navy, Navy Yard, Mare Island, Cal.; Frank Bowne Jones, yacht agent and ship broker, 29 Broadway, New York; Martin L. Katzenstein, 114 Liberty St., New York, manager marine department International Steam Lamp Co.; William McEntee, assistant naval constructor, U. S. Navy, Navy Yard, Mare Island, Cal.; George Theodore McKay, member of firm of Stearns & McKay, naval architects and yacht builders, Marblehead, Mass.; John Mitchell, vessel owner, member of the firm of Mitchell & Co., Rockefeller building, Cleveland, O.; Carle Ermanus Pfister, lieutenant, Royal Italian Navy, naval attache to the Italian Embassy, Washington, D. C.; Austin E. Potter, Frederick K. Lord, Charles E. Littlefield, Eugene M. Richardson, William R. Shoemaker.

Juniors: Robert Earle Anderson, C. E., 4th class ship draftsman, dept. of C. &. R., Navy Yard, New York; John Arnhold Engerdt inspector steam turbines, inspection and testing dept., Westinghouse Machine Co., East Pittsburg, Pa.; Sidney Graves Koon, editor *Marine Engineering*, 17 Battery Place, New York; Arthur Schultz Lewis, M. E. mechanical engineer in charge of test room, C. & R. dept., Navy Yard, New York; Daniel M. Luehrs.

Those present at the sessions and banquet were: J. J. Amory, W. J. Parslow, H. L. Aldrich, J. R. Andrews, D. Almy, F. E. Pratt, G. K. Brodfield, W. H. Barley, M. K. Bowman, J. Barre, G. H. Bates, F. T. Bowles, W. I. Babcock, H. Capdeville, D. H. Cox, G. L. Craig, E. S. Cramp, A. Crane, Robert Curr, G. C. Cook, J. A. Clifford, C. G. Curtis, R. Deming, D. W. Dickie, W. D. Dickey, W. D. Demock, F. L. DuBosque, J. Donald, R. D. Evans, J. B. Edson, F. L. Fernald, W. H. Fletcher, W. D. Forbes, D. E. Ford, G. N. Gardner, W. L. Guellander, G. N. Gardner, G. N. Gardner Jr., J. H. Gardner, W. G. Groesbeck, H. S. Grove, F. S. Hall, R. S. Haight, H. C. Higgins, C. H. Haswell, G. Hillman, J. C. Hyde, William Hovgaard, E. Johnson, F. B. Jones, L. Hatzenstein, M. L. Katjenstein, I. W. Kellogg, P. Leventhal, C. Kirchoff, S. S. Koon, John C. Kafer, J. J. Lynn, P. Leventhal, John Lloyd, John Leonard, E. M. McIlvain, C. D. Mosher, C. A. McAllister, J. E. Meek, J. W. Miller, Spencer Miller, M. F. Moore, A. Mority, J. H. Mull, Charles W. Martin, A. J. MacLean, L. J. Wilson, W. J. Norton, H. F. Norton, E. B. Osborn, N. F. Palmer, W. F. Palmer, C. H. Peabody,

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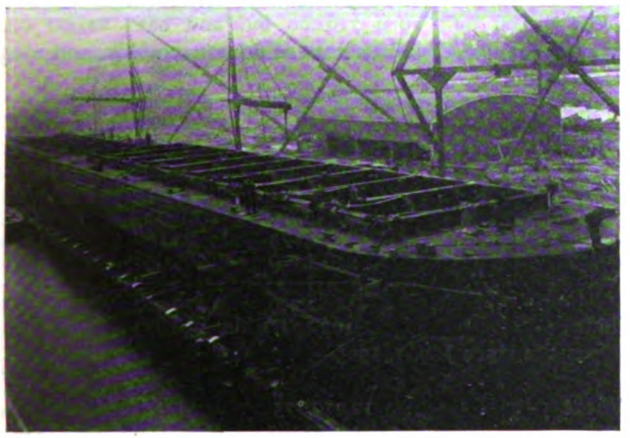
W. H. Phillips, John Platt, W. P. Robert, H. B. Roelker, T. F. Rowland, C. L. Seabury, H. C. Sadler, C. S. Smith, Horace Lee, F. B. Smith, G. C. Smith, L. Y. Spear, F. B. Smith, E. A. Stevens, H. G. Smith, F. H. Stillman, A. S. Stokes, E. P. Stratton, James Swan, F. J. Sprague, H. L. Snyder, W. P. Stephens, L. Taylor, G. K. Tuska, J. E. Thayer, J. C. Wallace, G. H. Waters, G. E. Weed, C. P. Wetherbee, H. Wilkman, J. G. Winship, H. Williams, G. P. Wilson, J. J. Woodward, G. A. White, Mr. Whittlesey, W. E. Voly, A. Vanderbilt, F. Van Vleck and C. W. Vollman, Rear admiral George W. Melville, John A. Macalpine, W. P. Stephens, naval constructor D. W. Taylor, F. Merriam Wheeler, John M. Mulrooney, admiral Washington L. Capps, James G. Winship, C. H. Crane, Charles D. Mosher, Aaron Vanderbilt, Harvey D. Goulder, Spencer Miller, naval instructor J. J. Woodward and Henry A. Magoon.

LARGEST DUMP SCOW ON THE LAKES.

In this day of record-breaking tonnage it is the custom to have the "largest" on the lakes, and the L. P. & J. A. Smith, Co., of Cleveland, have followed the rule in dredging circles. The Manitowoc Dry Dock Co., has just completed at their yard in Manitowoc, the largest dump scow ever built on fresh water. This monster scow has a rated capacity of one thousand cubic yards of mud weighing 1,620 tons and a possible capacity of 200 tons more.

The dimensions of the scow are as follows: length, over all, 180 ft.; beam, 40 ft.; depth, 12 ft. 6 in. There are ten hoppers of 14 ft. each, with a width of 25 ft. and a depth from top of coaming to the doors of 10 ft. 6 in. The doors are built of 8-in. oak and the coaming is protected by 6 in. of oak.



DUMP SCOW BUILT BY MANITOWOC DRYDOCK CO.

The scow is equipped with the latest improved hoisting gear operated by an engine placed in one of the compartments. The steam is supplied by the tug and the piping is so arranged as to allow the tug to make connection at any of the four corners. The same connection operates the syphons. The bulkheads, of which there are eleven on each side, are fitted with gate valves near the bottom, the stems extending just through the deck. The scow has been delivered to the owners, L. P. & J. A. Smith Co., of Cleveland, O. An illustration of the launch of the big scow is shown in the builder's advertisement on the front cover of this issue.

$250,000 TO TOW DRY DOCK DEWEY.

The navy department is proceeding actively with preparations for the trip of the new floating dry dock Dewey, from Chesapeake bay to the Philippines. The dock is now lying at Solomon's island, at the mouth of the Patuxent river, Maryland, and it is expected that she will leave about the middle of December, for her destination at Olongapo Naval Station in the Philippines. The colliers, Caesar and Brutus, and the refrigerating ship Glacier, have been assigned to the task of towing the dock, and these vessels are now being thoroughly overhauled under the personal supervision of Capt. Adolph Marix, U. S. N., inspector of naval auxiliaries. The colliers are at Norfolk navy yard, while the refrigerating ship is at Boston, being put in readiness for the long journey. It is understood that the colliers will be manned by crews of civilians, while the Glacier will be manned by a naval crew in command of Capt. W. F. Fullam, U. S. N.

It is estimated that the total cost of the transfer of the Dewey will be in the neighborhood of $250,000. The dock will be taken to the Orient via the Suez route, she being the largest craft which has ever passed through that waterway, and it is the expectation that the canal charges will be about $25,000. It is the expectation that only two of the vessels will be used in actual towing at a time, the third acting as a convoy for use in the event of an accident disabling either of the towing steamers. The colliers will be provided with the most liberal possible supplies of fuel, inasmuch as it is not the intention to have the Dewey enter any port en route, owing to the tonnage dues that might be exacted. The Suez route which is the same followed by the torpedo boat destroyer flotilla which went to the Philippines from the Atlantic seaboard (save that the torpedo craft touched at the West Indies) is 10,500 miles in length—3,000 miles shorter than the route via the Cape of Good Hope, and it is expected that the Dewey will cover the distance in about four months.

TWO MORE NEW STEAMERS TO BE BUILT

Two new wooden steamships are to be built for the Pacific Coast Steamship Co., both designed by James Dickie, of San Francisco, Cal. One of them is to be 237 ft. long, with a beam of 39 ft., will have triple expansion engines, oil burning apparatus, and a speed of 12 knots per hour with accommodations for a few passengers.

The hull will be built by Hall Bros., of Seattle, Wash., on the Puget Sound, and the machinery is to be furnished by Moran Brothers Co., of Seattle. The other vessel will take the place of the Gypsie recently wrecked on Monterey Bay. It will be constructed by Hall Bros., and the machinery by Moran Bros. and will have oil-burners, and be capable of making a speed of 10 knots per hour.

The Hamburg-American Line is the first transAtlantic steamship company to own its offices in New York city, having lately purchased the Aldrich Court building for $1,200,000. The New York office will be the center for all the company's business on the North American continent with Mr. Emil A. Boas as general manager. He will be assisted by Mr. Julius P. Meyer, Charles Stewart and W. G. Sickel as chiefs of their different departments. The New York freight department will continue to be in charge of Mr. F. G. Messmer.

The Atlantic Works, Inc., Philadelphia, Pa. has received an order from the New Orleans Dry Dock & Ship Building Co., New Orleans, La., for one of their improved B 17 adjustable bevel band saw machines for shipyard work.

The Rathbun-Lacy Co., Toledo, O., has been incorporated with a capital stock of $30,000 to build marine gas engines. The company will build engines from 3 H. P. to 15 H. P., in the two cycle type and from 20 H. P. up in the four cycle type. The officers of the company are: P. C. Jones, president; E. Rathbun, vice-president; V. E. Lacy, Jr., secretary, and W. L. Lamb, treasurer.

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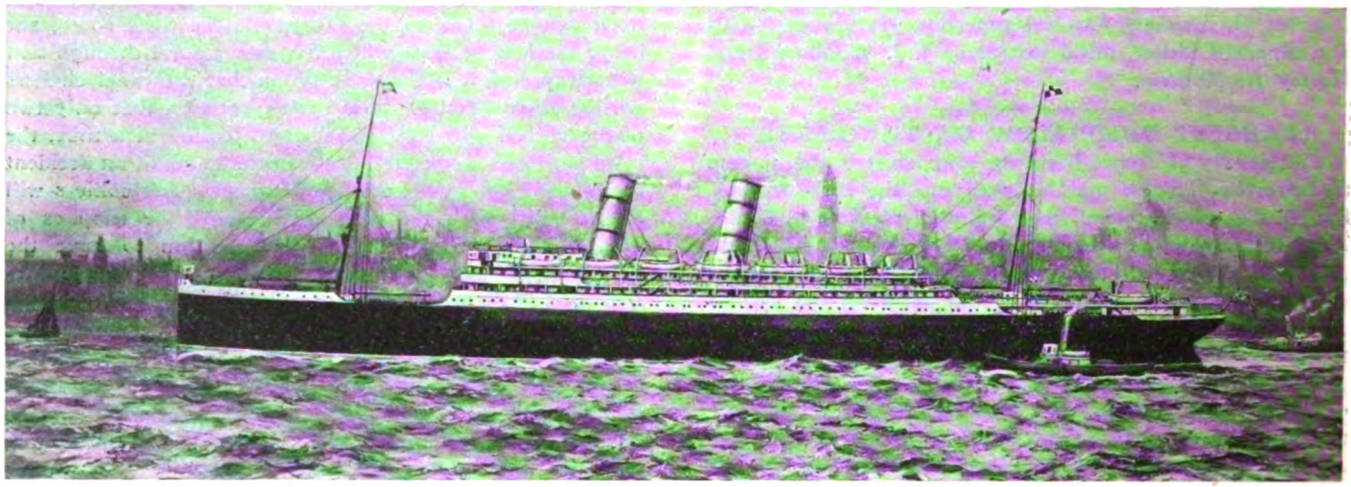
THE NEW CANADIAN PACIFIC STEAMERS

The accompanying illustration reproduced from a photo of Mr. Arthur Cox's painting of the new Canadian Pacific Railway steamers will give a good idea of these new vessels when they go into commission next year. These liners will be completed and placed in commission at the opening of the next Canadian season. They will be named the Empress of Britain and the Empress of Ireland. The former was launched on Nov. 11, and the Empress of Ireland will be put in the water about Jan. 20. The Canadian Pacific Railway Co. seems determined to be in the very front rank of the Canadian steamship services, and these two magnificent steamers, which will be larger and faster than any passenger steamer hitherto run on the route, will help materially to realize that ambition. In their construction many new features for the comfort and convenience of passengers, and the protection of perishable freight have been introduced. The company further are sparing no expense in the fitting out of these liners, which will have accommodation on a magnificent scale for a very large number of first, second and third class passengers. Their dimensions are: length, 550 ft. between perpendiculars; 570 ft. over all; beam, 65 ft.; depth, 40 ft., and gross register tonnage 14,500 tons. They will make the passage from Liverpool to Quebec in less than week. The company is looking forward with confidence to their acquisition.



NEW CANADIAN PACIFIC STEAMER EMPRESS OF BRITAN.

LAUNCH OF STEAMER BIXBY AT WYANDOTTE, NOV. 16

CHICAGO GRAIN REPORT

Chicago, Nov. 22.—The movement of past week notes a slight increase over the previous period: the shipping inquiry, however, rather a little in excess of vessel supply, rates ruled firmly @ 3¼c wheat, and 3c corn for Buffalo. It is expected this figure will continue throughout the present week.

Receipts are quite satisfactory and likewise the Eastern cash inquiry, but the great bulk of the traffic owing to the Buffalo congestion—favoring the railroads. The following not of distribution is self-explanatory: Via all rail lines of flour 112,052 bbls.; wheat 127,347 bu.; corn 905,595 bu.; oats 2,192,578 bu. and barley 355,000 bu. Via lake to Buffalo and other American ports of flour 78,900 bbls; wheat 95,000 bu.; corn 716,000 bu. and oats 82,000 bu. And Via lake to Canada points of flour 1,179 bbls. and oats 181,000 bu.

Lake and rail shipment—

	This Week	Last Week	Same Week last year.
Wheat	222,347	594,221	917,014
Corn	1,622,561	710,645	581,622
Oats	2,455,368	1,786,170	1,049,057
Rye	26,874	23,130	63,814
Barley	355,109	365,056	375,949
	4,682,259	3,479,222	2,987,456
Flour	192,198 Bbls.	258,883	123,385

Shipments since Jan. 1, 1905—

		Same Week last year
Wheat	12,019,175	15,794,144
Corn	83,659,187	65,473,074
Oats	55,899,309	42,800,853
Rye	1,029,568	1,416,512
Barley	5,577,946	4,896,337
	158,185,185	130,380,920
Flour	6,408,870 Bbls.	6,450,681

Stocks of grain in Elevators—

	This Week	Last Week	Same Week last year.
Wheat	8,802,000	7,495,000	3,903,000
Corn	1,464,000	1,235,000	750,000
Oats	13,478,000	13,739,000	8,855,000
Rye	555,000	461,000	434,000
Barley	342,000	395,000	143,000
	24,641,000	23,325,000	14,085,000

Capt. George B. Mallory of the steamer Amasa Stone was stricken with pneumonia on his steamer at the Sault and was brought to Lakeside Hospital, Cleveland, in a serious condition under the care of a physician.

Capt. Charles Christy will be master of the new Anchor Line steamer Delaware.

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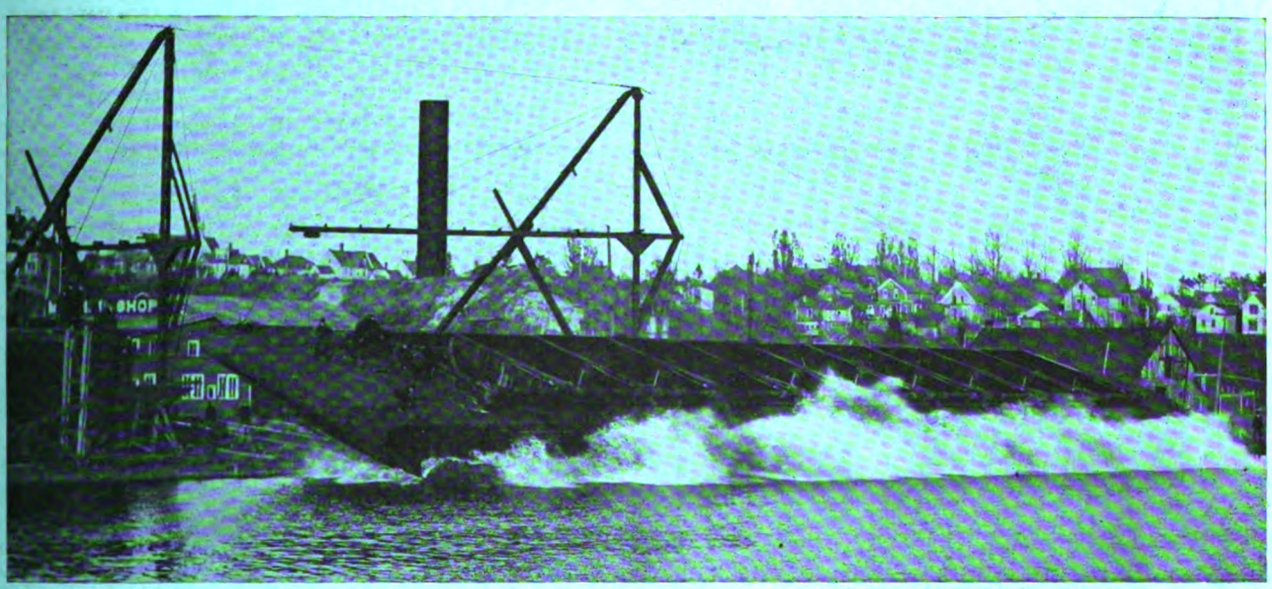
MARINE REVIEW

VOL. XXXII. CLEVELAND, NOVEMBER 23, 1905. NO. 21.

Manitowoc Dry Dock Company

MANITOWOC, WIS.



Launch of L. P. & J. A. Smith 1000 yard Steel Dump Scow.

Specialists in Design and Construction

OF

Passenger Steamers, Yachts, Tugs, Lighters,
Dipper and Suction Dredges, Dump Scows, Etc.

Complete equipment for economical repairs

Length of dry dock 350 feet
Floating dry dock 150 feet

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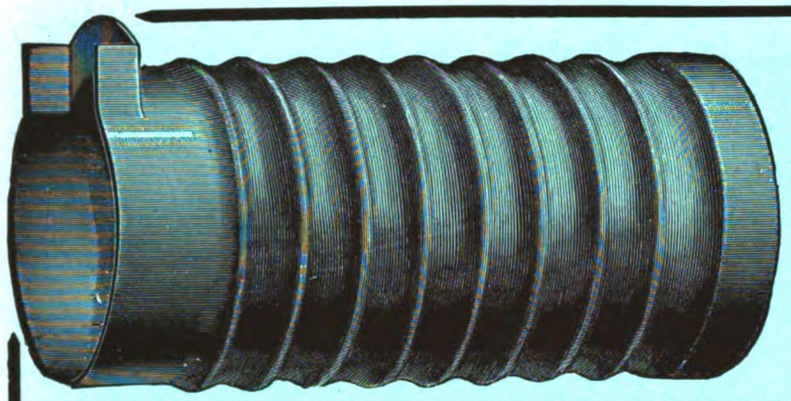

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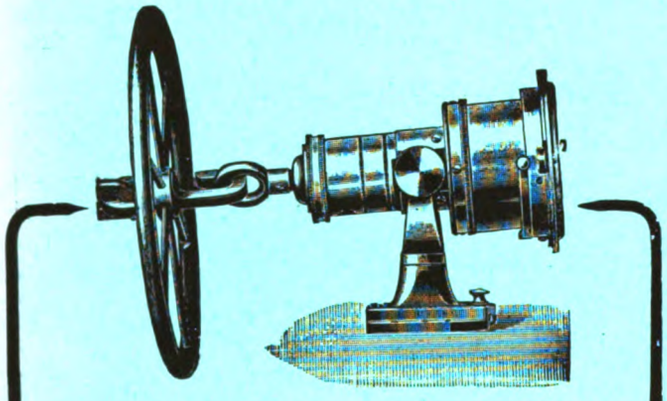
For Land and Marine Boilers

Uniform Thickness—Easily Cleaned
UNEXCELLED FOR STRENGTH

Also Fox Corrugated Furnaces

Manufactured by **THE CONTINENTAL IRON WORKS,** West and Cayler Sts., NEW YORK.
Near 10th and 23d Sts. Ferries
Borough of Brooklyn.



THE "NEPTUNE" LOG

The "Neptune" Ship Log has ball bearings for high speeds. We also make the "CHERUB" and "HARPOON" Ship Logs.

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THOMAS WALKER & SON

BIRMINGHAM, ENGLAND.

THE
BROWN HOISTING MACHINERY CO.
INCORPORATED

Sole makers of the "Brownhoist" High Speed Cantilever and Gantry Cranes. The most economical cranes for covering large areas in steel works or ship yards.

Machinery
for handling Structural Work,
Marine Plates, etc., in Ship Building Yards.

Coal and Ore Handling Machinery

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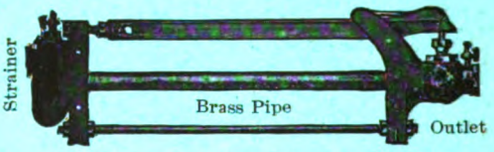

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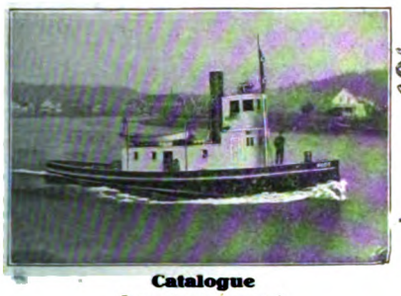

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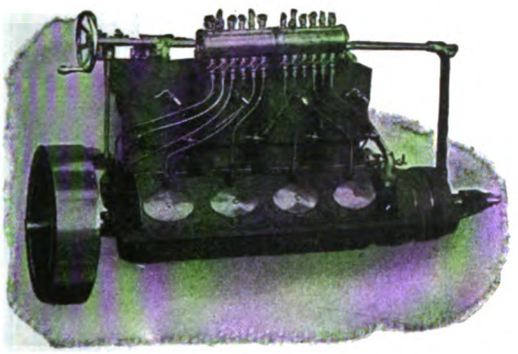

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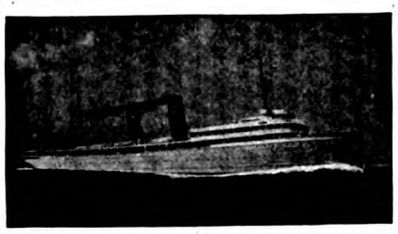

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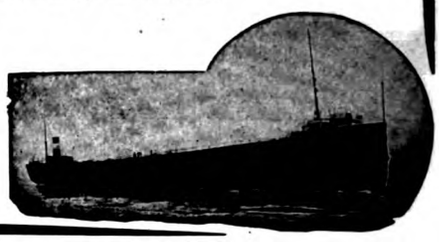

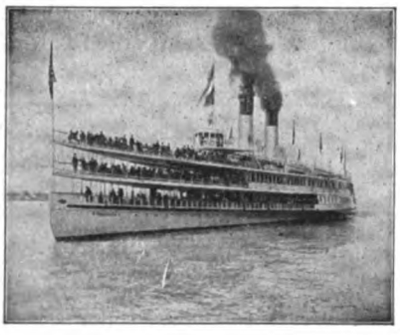

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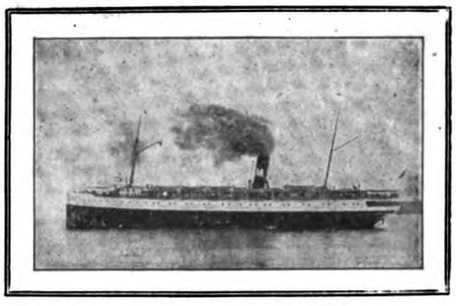

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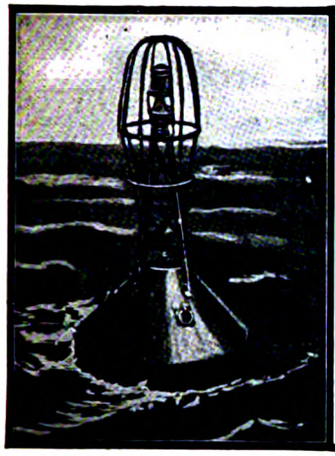

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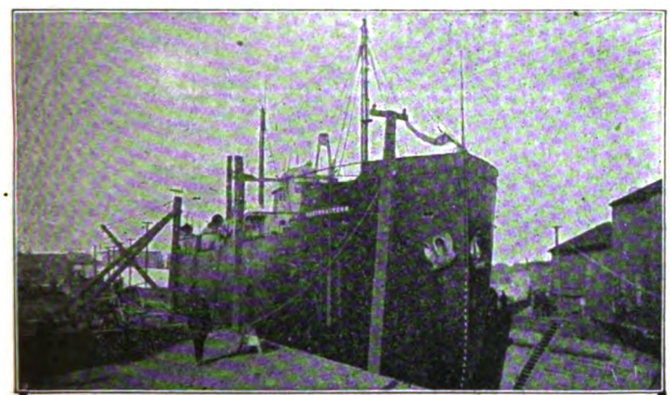

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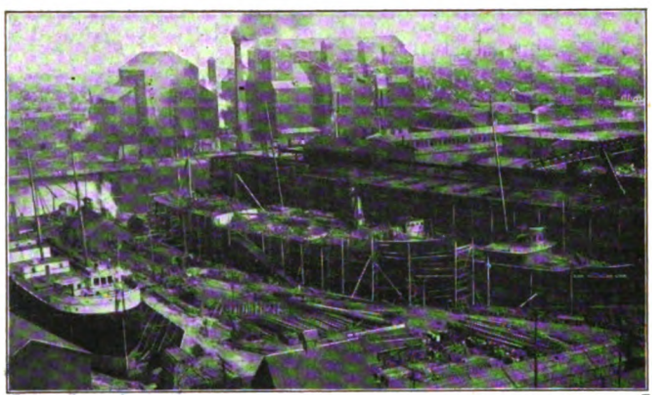

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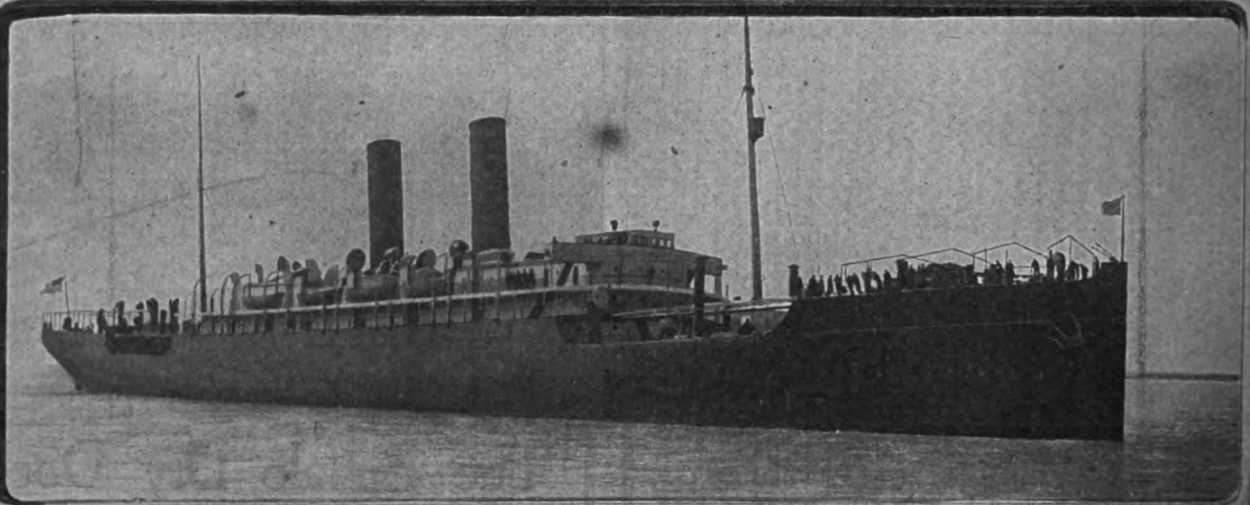

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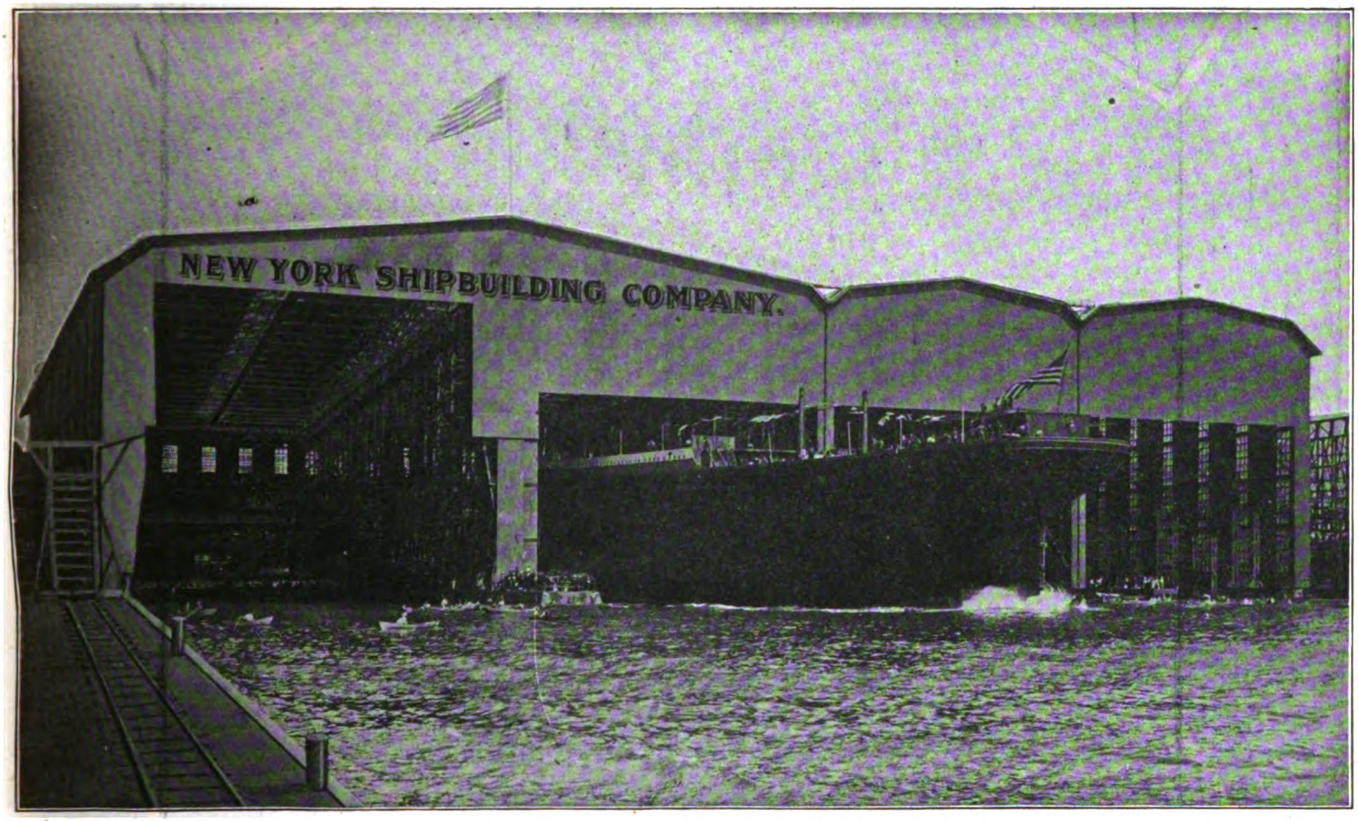

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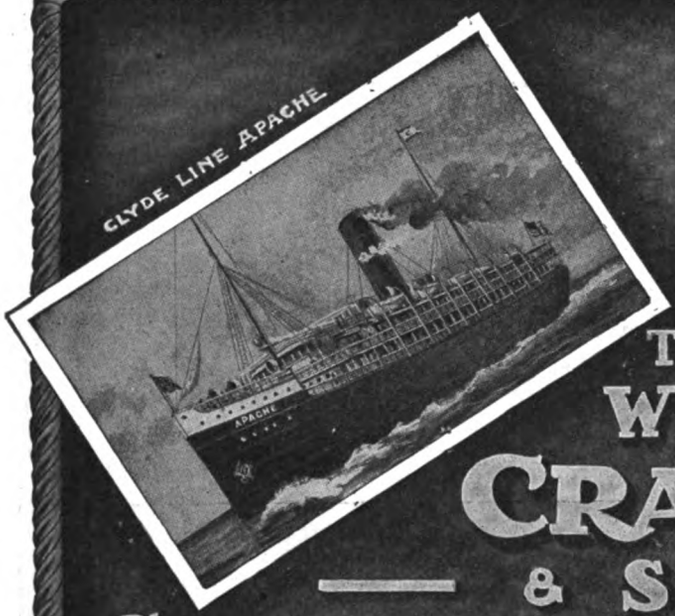

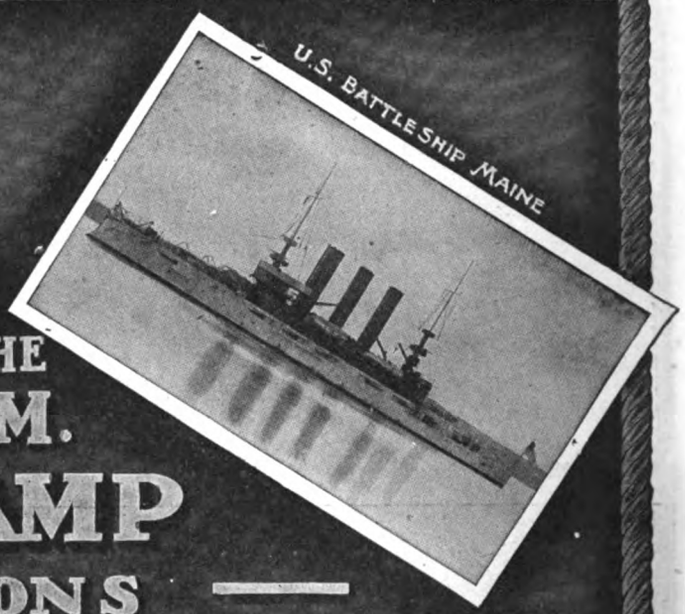

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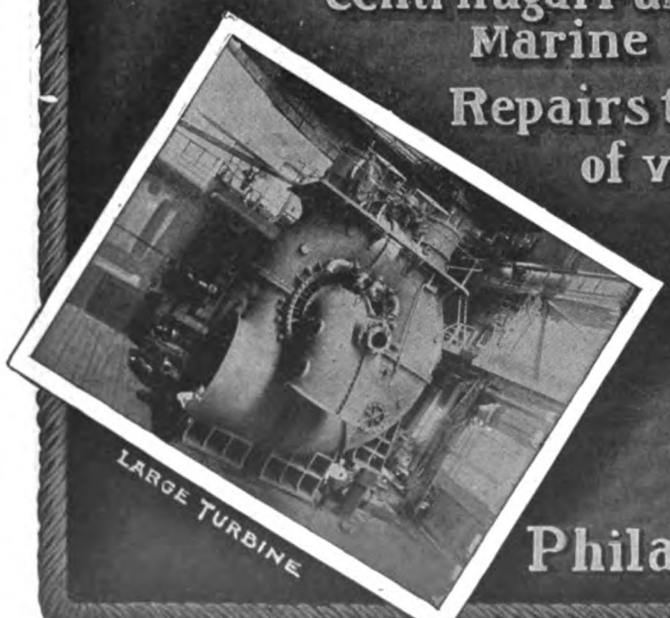

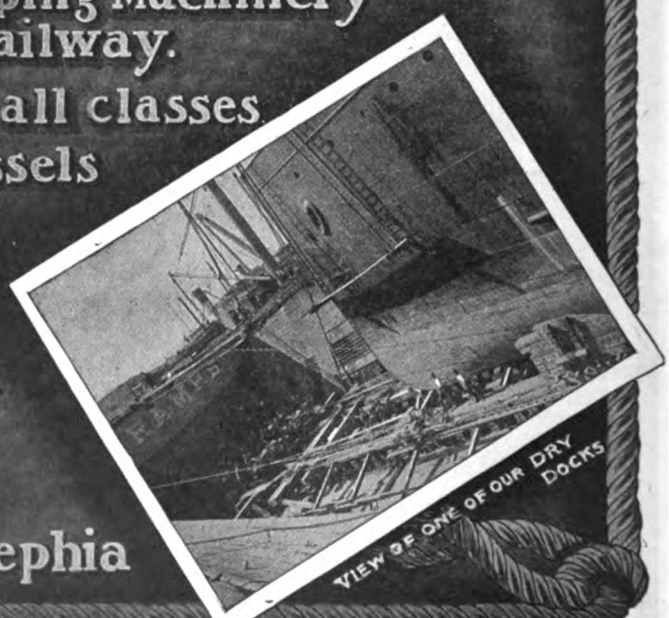

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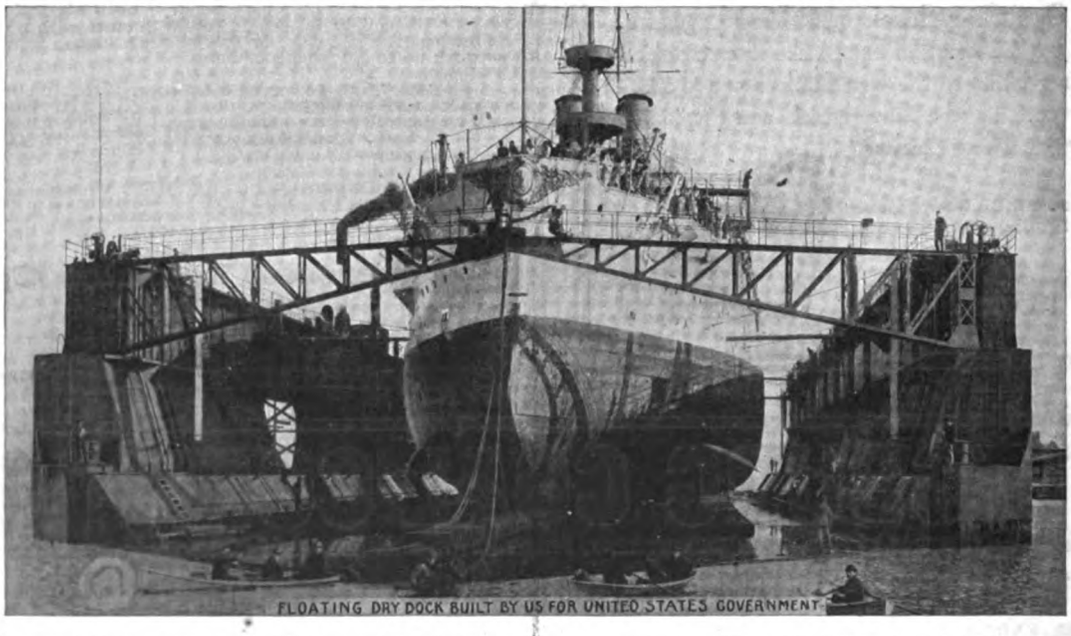

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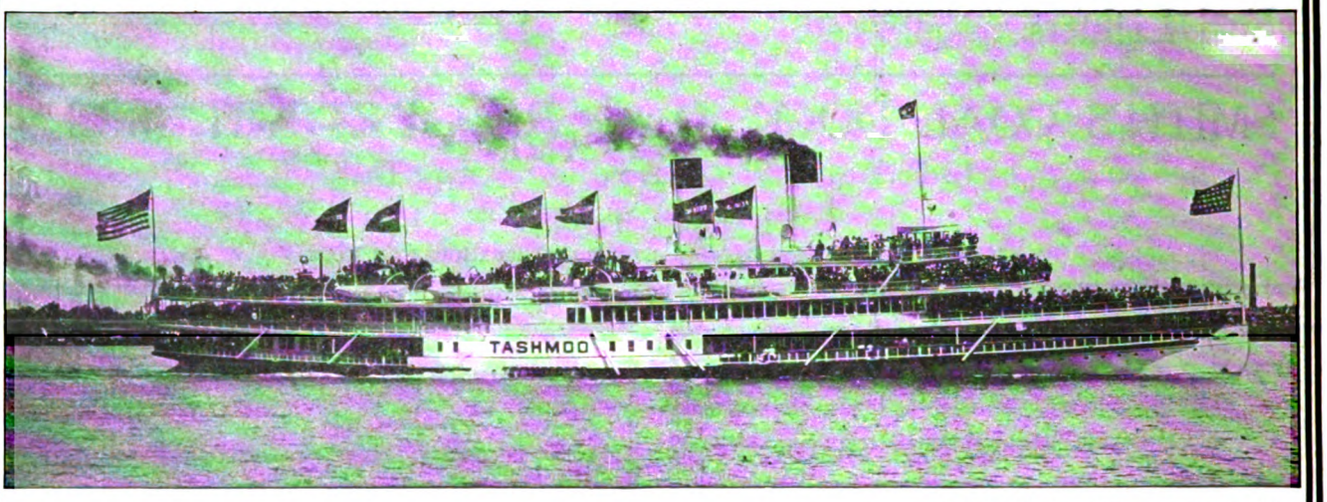

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Thompson, A. D. (Whaleback).
Toronto. (Thousand Islands).
Toronto. (Thousand Islands — at Alexandria Bay).
Toronto. (Thousand Islands — at Gananoque).
Transport, in Detroit River, Winter. (Car Ferry—Two Views.)
Troy.
Uganda, in Ship Canal at Duluth.
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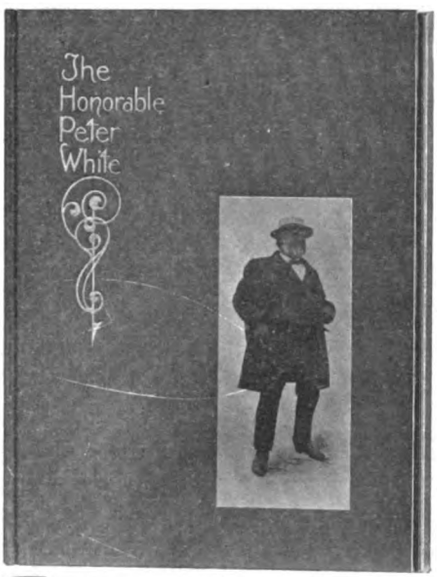

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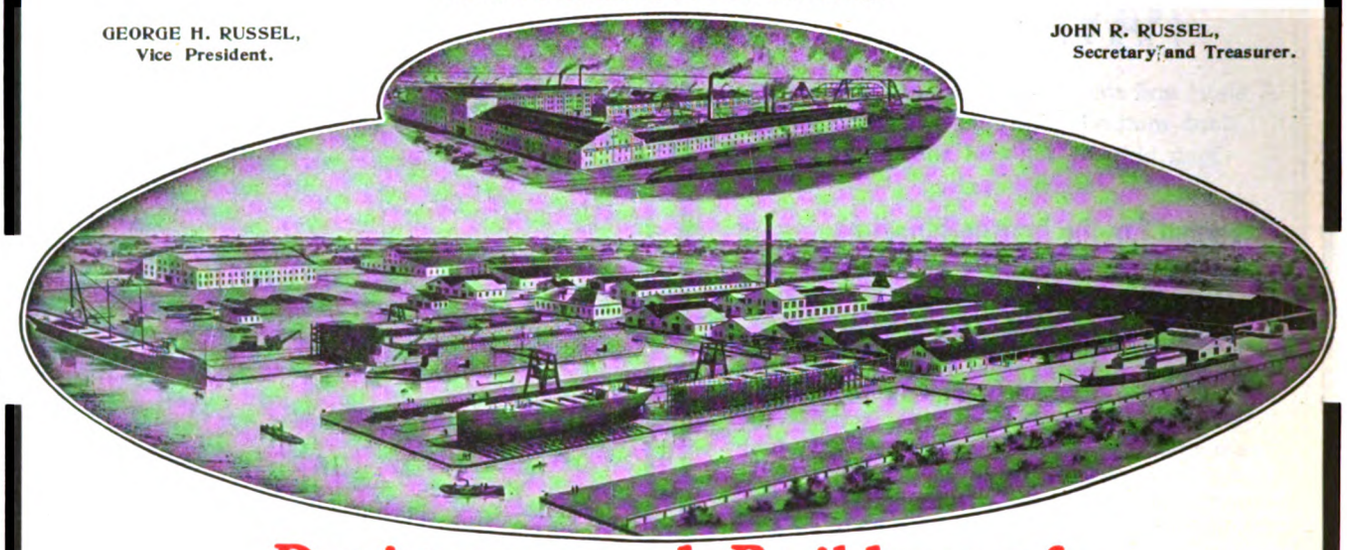

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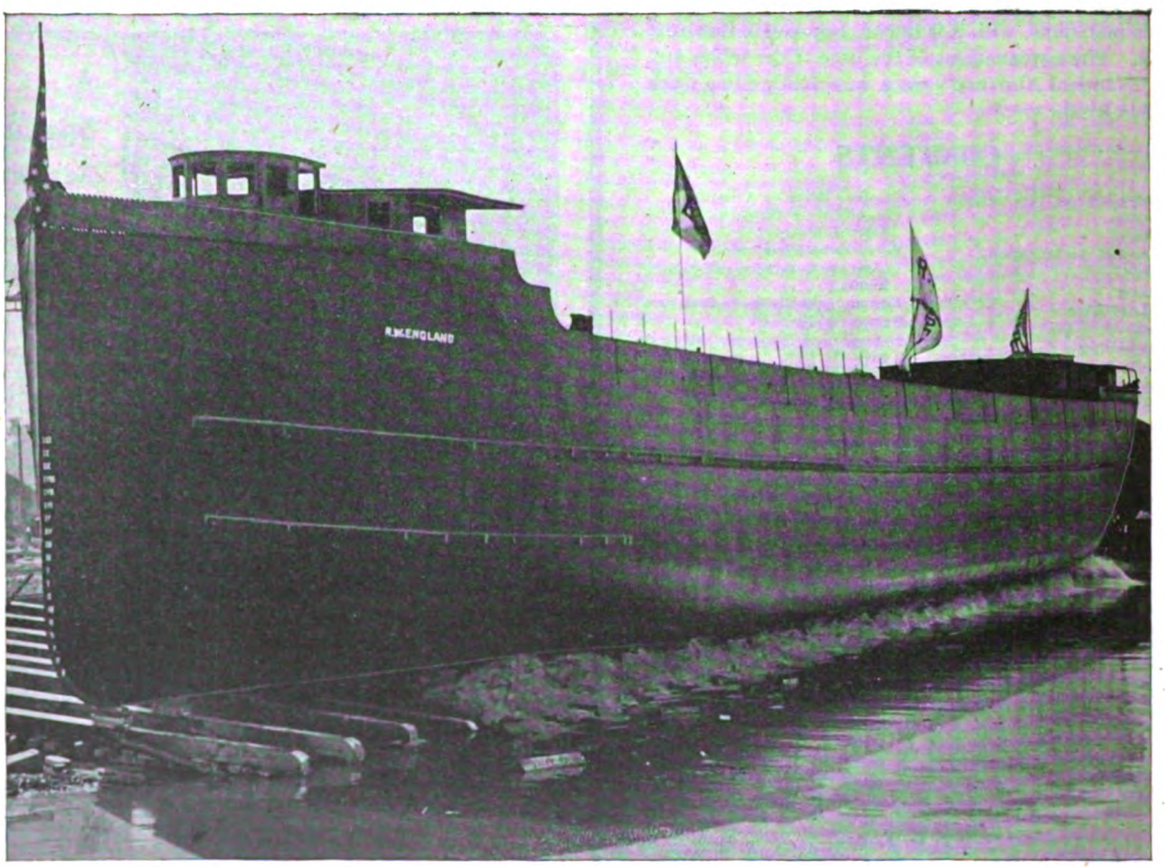

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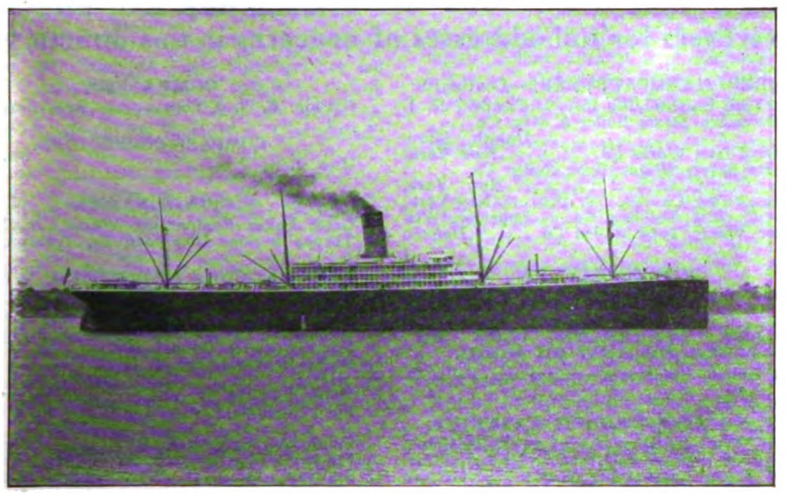

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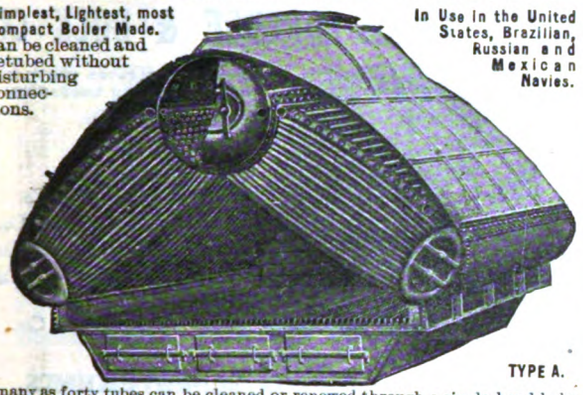

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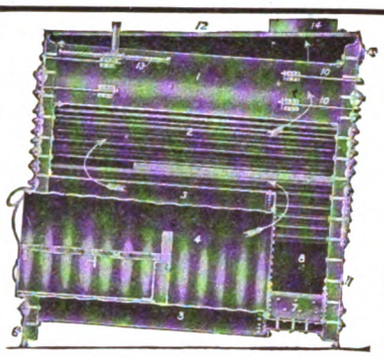

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Internally Fired.

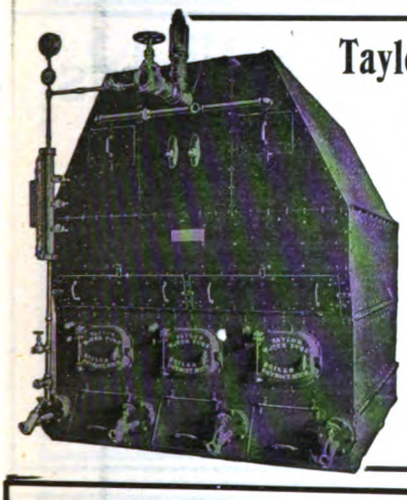
Scotch and Water Tube types combined, eliminating all objections.

Half the weight of ordinary Scotch boilers.

Standard corrugated furnaces.

Patent applied for. Investigate before buying any other.

EAST END BOILER WORKS
Detroit, Mich.



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Vertical Tubes, sectional, large steam space and liberating area.
Fire box, combustion chamber, and course for the furnace gases similar to the Scotch Marine.
Free circulation type.

Send for full description.

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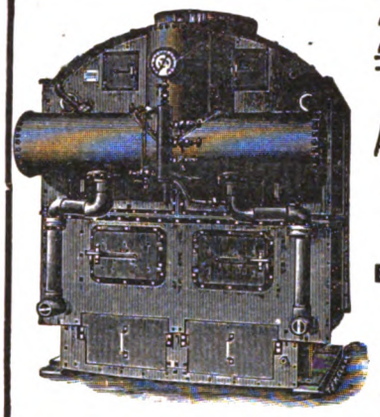

250 STEAM VESSELS

Now Equipped With

ALMY'S PATENT SECTIONAL Water Tube Boilers

Bear Evidence of Their

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PROVIDENCE, R. I.

John E. Thropp & Sons Co.
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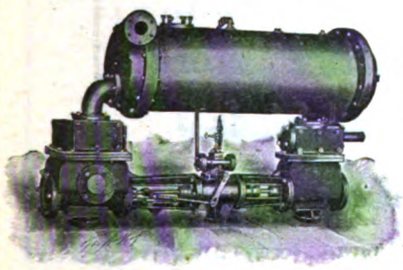
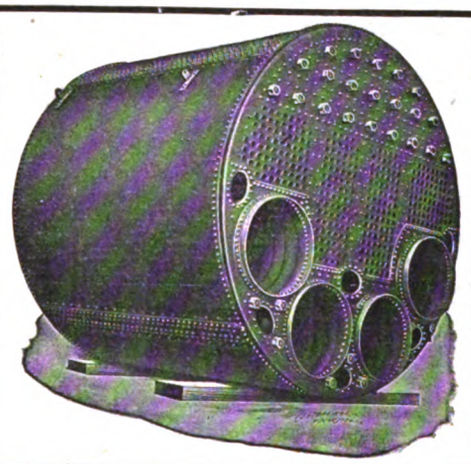


Builders of

Marine and Stationary Engines and Boilers.
Surface Condensers.
Propeller Wheels and Shafts.
Thrust Bearings.
Machinery of Every Description.



MARINE BOILERS

OF ALL TYPES

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Oswego, N.Y.

LATEST PATENT ANCHOR

THE NATIONAL

APPROVED BY LLOYDS.

Manufactured by

L. M. BOWERS & CO.,
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Furnished to the Lake Trade by

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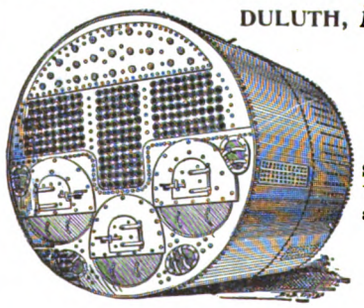

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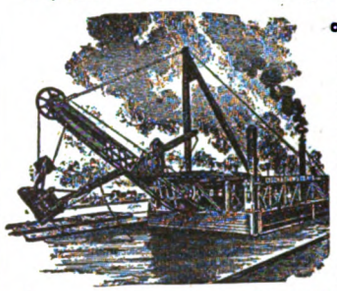

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Capacity, 1,000 tons. Draft, 7½ ft. forward, 13½ ft. aft. Length on keel blocks, 180 ft.; over all, 190 ft.

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To remove ROCK on Atlantic Coast to 40 ft. depth.
THAT'S ALL.

We SOMETIMES rent plant to responsible parties at OUR terms.

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Monroe Doctrine,	600 yds., Steel.
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McMyler derrick handling 10 tons at 75 ft. radius.

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Submarine Work
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Two 20-inch Hydraulic Dredges specially equipped for handling Clay, Gravel and all kinds of dredgeable material. Filling and reclaiming lands a specialty.

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SUBMARINE PIPE LAYING.

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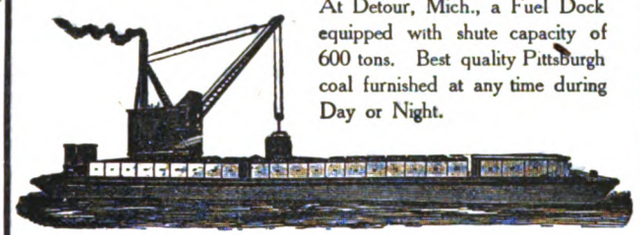
FUEL LIGHTERS at Buffalo, Erie, Ashtabula and Cleveland. At Detour, Mich., a Fuel Dock equipped with shute capacity of 600 tons. Best quality Pittsburgh coal furnished at any time during Day or Night.



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DREDGING OF ALL KINDS.

THE REMOVING OF DEEP WATER EARTH AND ROCK A SPECIALTY.

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BITUMINOUS COAL
For Steamboat Fuel and Cargo Shipment

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Steamboat Fuel at Ashtabula.
Large Supplies of Best Quality.

Lighter Carrying Different Grades at all Times.

Fuel Scow with elevators and discharging spouts. Storage of 800 tons. Discharges 250 tons an hour into steamers while unloading cargo.

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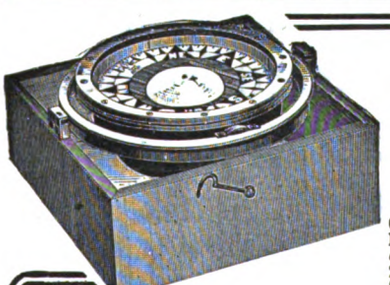

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Dunbar & Sullivan Dredging Co.....Buffalo.
Fitz-Simons & Connell Co.....Chicago.
Great Lakes Dredge & Dock Co.....Chicago.
Hickler Bros.....Sault Ste. Marie, Mich.
Hubbell Co., H. W.....Saginaw, Mich.
Lake Superior Contracting & Dredging Co. ..... Duluth, Minn.
Parker Bros. Co., Ltd.....Detroit.
Smith Co., L. P. & J. A.....Cleveland.
Starke Dredge & Dock Co., C. H..Milwaukee.
Sullivan, M..... Detroit

PIPE, WROUGHT IRON.

Bourne-Fuller Co.....Cleveland, O.
Macbeth Iron Co.....Cleveland.
Reading Iron Co.....Reading, Pa.

PLANING MILL MACHINERY.

Atlantic Works, Inc.....Philadelphia.

PLATES—SHIP, STRUCTURAL, ETC.

Bourne-Fuller Co.....Cleveland, O.
Otis Steel Co.....Cleveland.

PRESSURE REGULATORS.

Kieley & Mueller .....New York.
Ross Valve Co.....Troy, N. Y.

PROPELLER WHEELS.

American Ship Building Co.....Cleveland.
Atlantic Works.....East Boston, Mass.
Cramp, Wm. & Sons.....Philadelphia.
Detroit Ship Building Co.....Detroit.
Fore River Shipbuilding Co.....Quincy, Mass.
Great Lakes Engineering Works.....Detroit.
Hyde Windlass Co.....Bath, Me.
Lockwood Mfg. Co. .....East Boston, Mass.
Marine Iron Works.....Chicago.
Milwaukee Dry Dock Co.....Milwaukee.
Newport News Ship Building Co..... .....Newport News, Va.
Roelker, H. B.....New York.
Sheriffs Mfg. Co.....Milwaukee.
Superior Ship Building Co....Superior, Wis.
Thropp & Sons Co., J. E.....Trenton, N. J.
Trout, H. G.....Buffalo.

PROJECTORS, ELECTRIC.

General Electric Co.....Schenectady, N. Y.

PUMPS FOR VARIOUS PURPOSES.

Great Lakes Engineering Works.....Detroit.
Marine Iron Works.....Chicago.
Kingsford Foundry & Machine Works..... .....Oswego, N. Y.

PUNCHES AND SHEARS.

Sutton Co., C. E.....Toledo, O.

RANGES.

Stamford Foundry Co.....Stamford, Conn.

REFRIGERATING APPARATUS.

Great Lakes Engineering Works.....Detroit.
Roelker, H. B.....New York.

REGISTER FOR CLASSIFICATION OF VESSELS.

Great Lakes Register.....Cleveland.

RIVETS, STEEL FOR SHIPS AND BOILERS.

Bourne-Fuller Co.....Cleveland, O.

SAFETY VALVES.

Ashton Valve Co.....Boston.
Lunkenheimer Co. .....Cincinnati.

SAIL MAKERS.

Baker, Howard H. & Co.....Buffalo.
Upson-Walton Co.....Cleveland.

SALVAGE COMPANIES.

See Wrecking Companies.

SEARCH LIGHTS.

General Electric Co.....Schenectady, N. Y.

SHAFTING, HOLLOW.

Falls Hollow Staybolt Co..Cuyahoga Falls, O.

SHEARS.

See Punches, and Shears.

SHIP AND BOILER PLATES AND SHAPES.

Bourne-Fuller Co.....Cleveland, O.
Otis Steel Co.....Cleveland.

SHIP BUILDERS.

American Ship Building Co.....Cleveland.
Atlantic Works .....East Boston, Mass.
Buffalo Dry Dock Co.....Buffalo.
Cramp, Wm. & Sons.....Philadelphia.
Craig Ship Building Co. .....Toledo, O.
Chicago Ship Building Co.....Chicago.
Detroit Ship Building Co.....Detroit.
Fore River Shipbuilding Co.....Quincy, Mass.
Great Lakes Engineering Works.....Detroit.
Lockwood Mfg. Co.....East Boston, Mass.
Manitowoc Dry Dock Co.....Manitowoc, Wis.
Maryland Steel Co.....Sparrows Point, Md.
Milwaukee Dry Dock Co.....Milwaukee.
Newport News Ship Building Co..... .....Newport News, Va.
New York Shipbuilding Co....Camden, N. J.
Roach's Ship Yard.....Chester, Pa.
Shipowner's Dry Dock Co.....Chicago.

SHIP CHANDLERS.

Baker, Howard H. & Co.....Buffalo.
Marine Mfg. & Supply Co.....New York.
Upson-Walton Co.....Cleveland.

SHIP DESIGNERS.

Kidd, Joseph .....Duluth.
Steel, Nacey & Hynd.....Cleveland.
Wood, W. J.....Chicago.

SHIP LANTERNS AND LAMPS.

Russell & Watson.....Buffalo.

SHIPMATE RANGES.

Stamford Foundry Co.....Stamford, Conn.

SHIP TIMBER.

Martin-Barriss Co.....Cleveland.
Rayner, J. .....Chicago.

SMOOTH-ON COMPOUND, FOR REPAIRS.

Smooth-On Mfg. Co.....Jersey City, N. J.

STAYBOLT IRON OR STEEL BARS, HOLLOW OR SOLID.

Falls Hollow Staybolt Co..Cuyahoga Falls, O.

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Gilchrist & Co., C. P.....Cleveland.
Holmes, Samuel .....New York.
Lester, S. S.....Quebec, Can.
McCarthy, T. R.....Montreal, Can.

STEAMSHIP LINES, PASS. AND FREIGHT.

American Line .....New York.
Anchor Line .....Buffalo.
Boston Steamship Co.....Boston.
Cleveland & Buffalo Transit Co.....Cleveland.
International Mercantile Marine Co..... .....Philadelphia.
Mallory Line ....New York.
Merchants' Montreal Line.....Montreal.
New York & Cuba Mail S. S. Co...New York.
Red Star Line.....New York.
United Fruit Co.....Boston

STEEL CASTINGS.

Otis Steel Co.....Cleveland.
Sutton Co., C. E.....Toledo, O.

STEERING APPARATUS.

American Ship Building Co.....Cleveland.
Chase Machine Co.....Cleveland.
Detroit Ship Building Co.....Detroit.
Hyde Windlass Co.....Bath, Me.
Marine Mfg. & Supply Co.....New York.
Moulton Steering Engine Co.....New York.
Sheriffs Mfg. Co.....Milwaukee.

SUBMARINE DIVING APPARATUS.

Morse & Son, A. J.....Boston.
Schrader's Son, Inc., A..... ....New York.

SURVEYORS, MARINE.

Gaskin, Edward .....Buffalo.
Hynd, Alexander .....Cleveland.
Parker Bros. Co., Ltd.....Detroit.
Nacey, James .....Cleveland.
Steel, Adam .....Cleveland.
Wood, W. J.....Chicago.

TESTS OF MATERIALS.

Hunt, Robert W. & Co.....Chicago.
Lunkenheimer Co.....Cincinnati, O.

TOOLS, METAL WORKING, FOR SHIP AND ENGINE WORKS.

Watson-Stillman Co.....New York.

TOOLS, WOOD WORKING.

Atlantic Works, Inc.....Philadelphia

TOWING MACHINES.

American Ship Windlass Co..Providence, R. I.
Chase Machine Co.....Cleveland.

TOWING COMPANIES.

Donnelly Salvage & Wrecking Co..... .....Kingston, Ont.
Great Lakes Towing Co.....Cleveland.

TRAPS, STEAM.

Kieley & Mueller .....New York.
Sturtevant Co., B. F.....Hyde Park, Mass.

TRUCKS.

Boston & Lockport Block Co.....Boston.

TUBING, SEAMLESS.

Shelby Steel Tube Co.....Pittsburg, Pa.

VALVES, STEAM SPECIALTIES, ETC.

Ashton Valve Co.....Boston.
Jenkins Bros. .....New York.
Kieley & Mueller.....New York.
Lunkenheimer Co.....Cincinnati.
Ross Valve Co.....Troy, N. Y.

VALVES FOR WATER AND GAS.

Lunkenheimer Co.....Cincinnati.
Ross Valve Co.....Troy, N. Y.

VARNISHES.

Detroit Varnish Co.....Detroit.
Detroit White Lead Works.....Detroit.
Also Ship Chandlers.

VENTILATING APPARATUS FOR SHIPS.

Sturtevant, B. F. Co.....Hyde Park, Mass.
Sutton Co., C. E.....Toledo, O.

VESSEL AND FREIGHT AGENTS.

Boland, John J.....Buffalo.
Brown & Co.....Buffalo.
Elphicke, C. W. & Co.....Chicago.
Fleming & Co., E. J.....Chicago.
Gilchrist & Co., C. P.....Cleveland.
Hall, John B.....Buffalo.
Helm & Co., D. T.....Duluth.
Hawgood & Co., W. A.....Cleveland.
Holmes, Samuel .....New York.
Hutchinson & Co.....Cleveland.
Lester, S. S. .....Quebec, Can.
McCarthy, T. R.....Montreal.
Mitchell & Co.....Cleveland.
Parker Bros. Co., Ltd.....Detroit.
Prindiville & Co.....Chicago.
Richardson, W. C.....Cleveland.
Sullivan, D. & Co.....Chicago.

WATER GAUGES.

Bonner Co., Wm. T.....Boston.
Lunkenheimer Co.....Cincinnati, O.

WATERTIGHT BULKHEAD DOORS.

"Long Arm" System Co.....Cleveland.

WHISTLES, STEAM.

Ashton Valve Co.....Boston.
Lunkenheimer Co..... Cincinnati.

WILFORD'S WATERPROOF CLOTH.

Bunker, E. A. .....New York.

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Upson-Walton Co.....Cleveland.

WINDLASSES.

American Ship Windlass Co..Providence, R. I.
American Ship Building Co.....Cleveland.
Hyde Windlass Co.....Bath, Me.
Marine Mfg. & Supply Co.....New York.

WINCHES.

American Ship Windlass Co..Providence, R. I.
Georgian Bay Engineering Works..... .....Midland, Ont.
Hyde Windlass Co.....Bath, Me.

WOOD WORKING MACHINERY.

Atlantic Works, Inc.....Philadelphia.

WRECKING AND SALVAGE COMPANIES.

Donnelly Salvage & Wrecking Co..... .....Kingston, Ont.
Great Lakes Towing Co.....Cleveland.
Parker Bros. Co., Ltd.....Detroit.

YACHT AND BOAT BUILDERS.

Drein, Thos. & Son.....Wilmington, Del.
Manitowoc Dry Dock Co.....Manitowoc, Wis.
Truscott Boat Mfg. Co.....St. Joseph, Mich.

YAWLS.

Drein, Thos. & Son.....Wilmington, Del.

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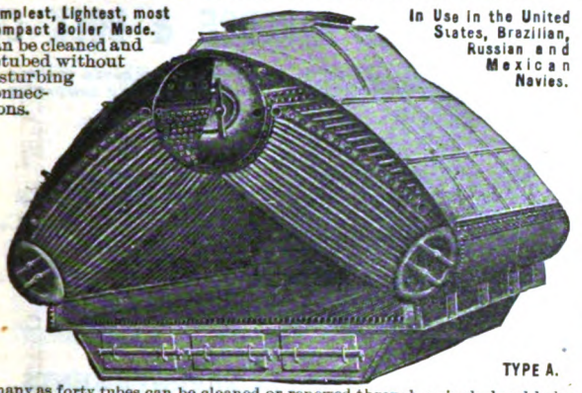

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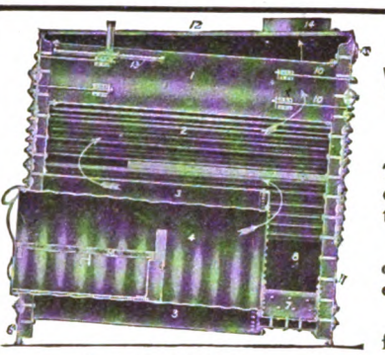
As many as forty tubes can be cleaned or renewed through a single hand-hole; has greater steam and water capacity than any other water tube boiler. Send for descriptive catalogue.

MOSHER WATER TUBE BOILER CO., NO. 1 BROADWAY, N. Y.



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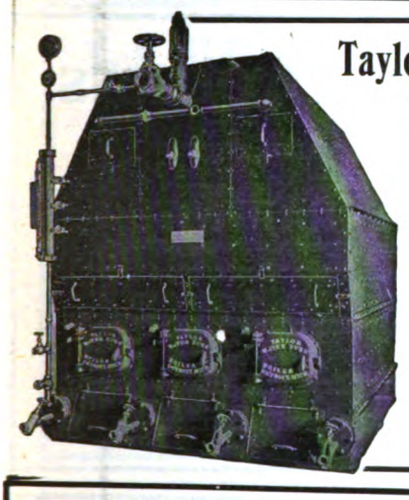

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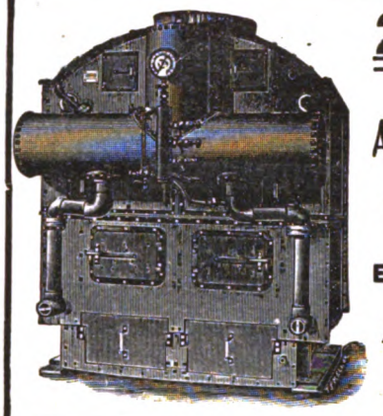

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PROVIDENCE, R. I.

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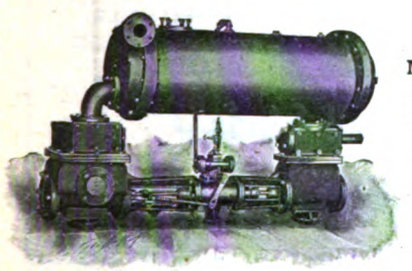

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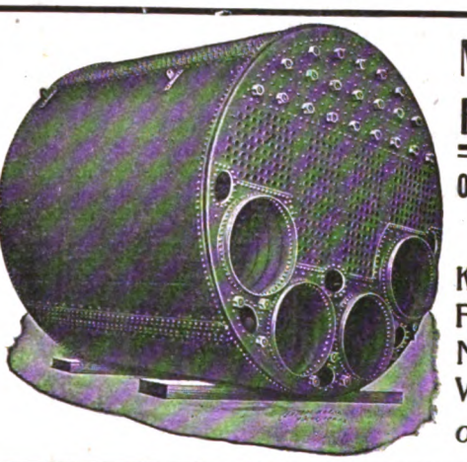

MARINE BOILERS

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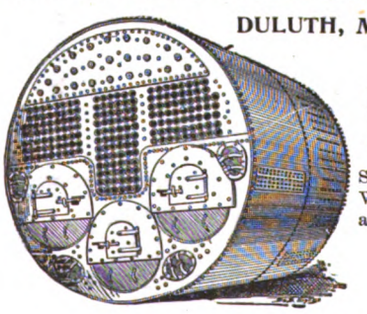

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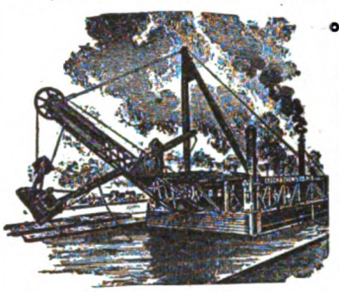

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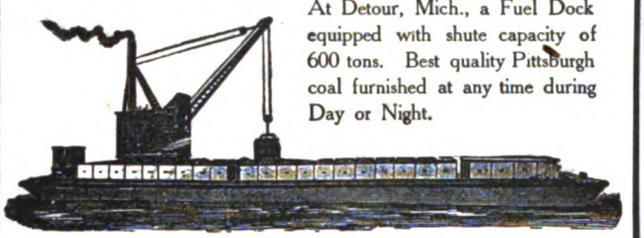

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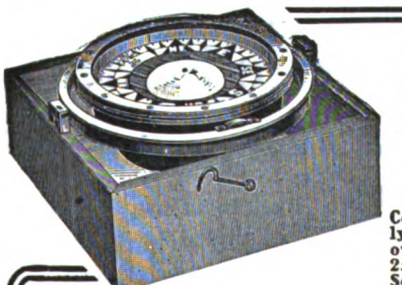

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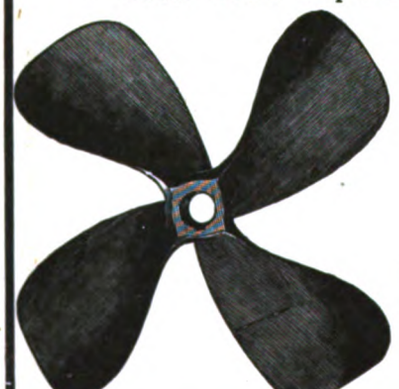

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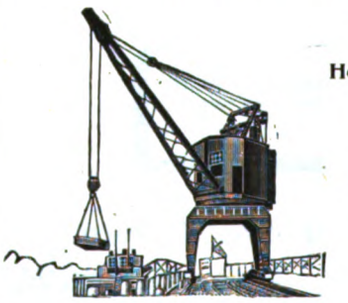

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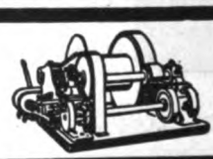

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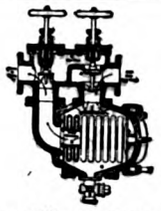

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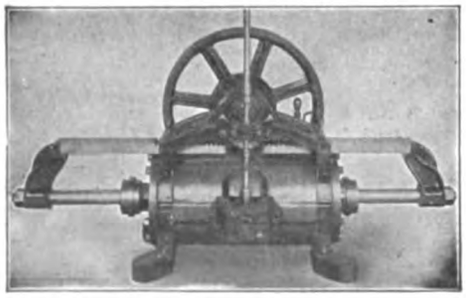

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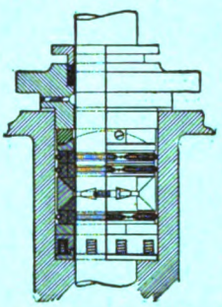

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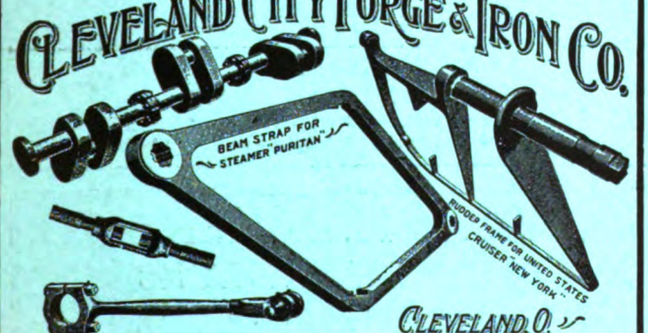

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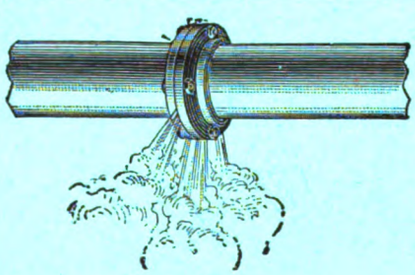

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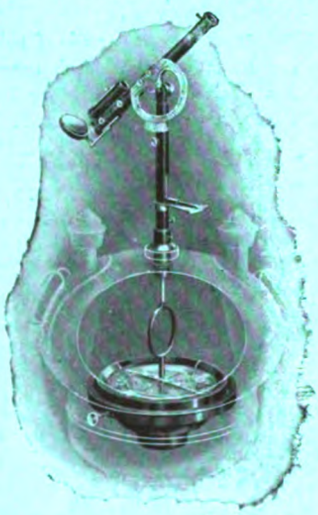

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